ANALYSIS OF RESPONSE HIERARCHIES IN INDIVIDUAL WITH MULTIPLE TOPOGRAPHIES OF STEREOTYPIC BEHAVIOR

By

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ANALYSIS OF RESPONSE HIERARCHIES IN INDIVIDUALS WITH MULTIPLE TOPOGRAPHIES OF STEREOTYPIC BEHAVIOR

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The percentage of time five children with autism or other developmental disabilities allocated to topographies of stereotypy was assessed in a series of studies involving free-operant, restricted-operant, enriched environments, and combined conditions. To determine each child's preference for specific stereotyped responses (measured by time allocation), free operant levels of stereotypy were first evaluated during alone conditions. Thereafter, the most preferred response was either restricted or the environment was enriched with preferred stimuli. Time allocation to remaining stereotyped responses was further evaluated. Subsequently, the response that emerged as most preferred during the first restriction phase was restricted and response allocation was again evaluated. The results for three participants show that restriction of the most preferred response was correlated with co-varying reductions in a non-targeted stereotypy. In addition, two participants exhibited consistent patterns of reallocation to a previously less preferred topography of stereotypy under conditions of restriction.

CHAPTER 1
LITERATURE REVIEW

The term "stereotypy" has been used in many different ways. In describing usage of the term, Schroeder (1970) cited research in the broad ranging areas of social psychology, experimental psychology, and clinical application. Schroeder suggested, and subsequent literature tended to support, that the term should be reserved to describe repetitious acts and invariant sequences of behavior exhibited by a single organism. As such, the term "stereotypy" maintains descriptive utility in both applied/clinical and experimental realms, but it might represent various behavioral phenomena.

Berkson (1967) was among the first researchers to carefully examine repetitive behavior exhibited by individuals with developmental disabilities. Berkson identified two broad categories of stereotyped behavior. These categories include repetitive movements, such as body rocking, and non-repetitive movements, such a limb or body posturing. The common element of "invariance" apparently led Berkson to call the responses "stereotypy." Berkson's usage of the term stereotypy seems to differ from Schroeder's (1970) usage in that limb and body posturing were not repetitive.

Subsequent authors, such as Lewis and Baumeister (1982), further stipulated that stereotypy is nonfunctional and is not marked by a clear antecedent stimulus. Also, the topography of many stereotypies is said to contain an element of rhythmicity (e.g., Lewis & Baumeister, 1982; Ross, Yu, & Kropla, 1998), a term intended to convey regularity in amplitude (i.e., systematic front-to-back movement) or sequence of behaviors (e.g.,

staring at the hand, then flapping the hand). Since its initial use as a behavioral descriptor, rhythmicity has been refined and more clearly operationalized.

In a review of literature pertaining to repetitive behavior, Berkson (1983) stipulated that stereotyped responses should be categorized using the following criteria: a) the behavior is voluntary (implying that the behavior is operant as opposed to respondent), b) the behavior lacks variability, c) the behavior persists over time (e.g., for at least several months), d) the behavior is immutable when faced with environmental changes, and e) the behavior is out of synchrony with the individual's expected age-related development. More recently, the characteristic of invariability has been challenged by Newell, Incledon, Bodfish, and Sprague (1999) who found evidence that the stereotypic body rocking of individuals with a developmental disabilities (DD) was actually more variable than the "artificial" rocking of non DD individuals in a control group (i.e., persons who were instructed to body rock). These results suggest that use of response invariability as a defining characteristic should be re-examined. Nevertheless, the method by which the conclusions from the Newell et al. study were rendered has been called into question (Berkson, Andriachhi, & Sherman, 2001).

Many researchers have also hypothesized that repetitive behavior (i.e., stereotypy) produces "feedback" or "self-stimulation," implicating the role of reinforcement (e.g., Lovass, Newsom, & Hickman, 1987; Smith & Van Houten, 1996). The underpinning of reinforcement hypotheses is that the behavior itself provides its own source of reinforcement and no social mediation is necessary to support the behavior. Thus, in the view of some researchers, stereotypy is automatically reinforced; however, it does not follow that all automatically reinforced behavior is stereotypy (e.g., playing a musical

instrument). Unlike many other purported behavioral dimensions of stereotypy, the characteristic of "self-stimulation" appears amenable to experimental analysis (i.e., functional analysis; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

Tierney, McGuire, and Walton (1978) contended that the problematic element of stereotyped behavior is the amount of time the referent individual spends engaged in the behavior of concern. Other researchers have alluded to time allocation in terms of a behavior being "high frequency" (e.g., Lewis & Baumeister, 1982), but few have proposed defining parameters. As such, Tierney et al. support the use of real time measurements of stereotypy to arrive at more absolute measures. Similarly, Sackett (1978) suggested that stereotypy should be further quantified on the dimension of time with a ratio depicting time allocated to stereotypy over time allocated to appropriate behavior. As educators often report difficulties in teaching new skills to children who engage in stereotypy, due to the dominance of such responses, the ratio proposed by Sackett may provide a contextually valid approach for describing a problem behavior with a simple index.

Population Characteristics

Although the literature suggests that specific topographies of stereotypy (e.g., body rocking) are more common, there have been dozens if not hundreds of response forms called stereotypy in the literature. In addition, stereotypic response forms are most commonly deemed problematic when exhibited by individuals diagnosed with developmental disabilities (DD) beyond a certain age (i.e., in early childhood). Nevertheless, it does appear that many of the behaviors that have ultimately met researchers' definition(s) of stereotypy were, at one time, exhibited during normal development (i.e., the behavior is also exhibited by typically functioning infants).

Thelen (1979) conducted naturalistic observations of 20 "normally developing" infants over the course of each child's first year of life. Rhythmical stereotypy was defined as three or more repetitive movements of the whole body or a part within 1 s or less. Data for each behavior were collected using a 30-s partial-interval recording method. Observations across children suggested that these behaviors were exhibited with consistent form and time allocation. Interestingly, specific behaviors were more likely to be exhibited, and then eventually diminish, within certain age parameters.

Thelen's (1979) data were presented as the average time infants (as a group) engaged in stereotypies across age in weeks. The aggregated data indicated that 20-week-old infants allocated over 40% of their time to behavior defined as stereotypy. However, because Thelen used a partial-interval recording method that contained a 30-s interval, it is difficult to conclude that the infant indeed allocated this amount of time to rhythmical stereotypy. Similarly, because data for specific behaviors were collapsed into one inclusive category and sequences of behavior were not displayed for any given time segment (e.g., across two hours of observation), it is possible that variant behaviors were labeled as "stereotypy." If such behavior were included in the analyses, this method of categorization would be in conflict with more widely accepted definitions of stereotypy (e.g., Lewis & Baumeister, 1982).

Thelen (1979) interpreted the results of her naturalistic observations in terms of developmental stages and neuromuscular maturation. The utility of Thelen's approach to the study of repetitive behavior as it pertains to normal development is exemplified in the consistent order in which behaviors are exhibited across individuals. However, explaining these observations in terms of internal and unobservable processes does little to increase

understanding of repetitive behavior that persists to a point of being labeled deviant or problematic.

Schwartz, Gallagher, and Berkson (1986) advanced Thelen's work by evaluating two response forms (hand gazing and body rocking) that were previously observed in both normally developing and developmentally delayed infants. Swartz et al. examined potential topographical similarities and differences between hand gazing and body rocking across the two groups for both behaviors. Though selection criteria were not specified, the developmentally delayed infants, who were observed for body rocking and hand gazing, were between 19 and 23 months of age, while the typically developing infants were between 4 and 9 months of age, respectively. Data were collected on multiple objective and subjective dimensions of the target behavior, including duration (total time for each occurrence), repetition (present or absent) for hand gazing and rate (movement forward and backward constituted one cycle) and amplitude of body rocking. In general, statistical analyses of behavioral measures of hand gazing indicated that the infants with disabilities engaged in greater duration and more repetitions of this behavior. Similarly, infants with developmental disabilities engaged in a greater number of body-rocking repetitions, which translated into more time allocated to the response. Likewise, subjectively rated observations suggested that amplitude of the front-to-back movement was also greater (i.e., more obvious to naïve observers) for this group.

Investigation of the development of repetitive behavior has also been extended to older children diagnosed with developmental disabilities. Smith and Van Houten (1996) compared the repetitive behavior (stereotypy) of adolescents diagnosed with developmental disabilities to repetitive behavior displayed by age-matched peers of

typical intellectual functioning under a variety of stimulus conditions. Data for each participant's behavior were collected using a 10-s partial interval recording method during 5-min observation sessions. The experimenters also categorized behavior based on the speed of the repetitions (two or less per second as "slow"; three or more per second as "fast"), orientation of the performer's eyes during the behavior, whether the behavior involved large muscle groups (gross motor) or small muscle groups (fine motor), and whether the behavior was obvious (was easily detected) or subtle (required careful observation to detect). In general, the results indicated that individuals in the developmentally typically and disabled groups engaged in comparable levels (i.e., frequencies) of repetitive behavior. However, the behavior of individuals in these respective groups appeared to differ along qualitative dimensions. That is, individuals with developmental delays, unlike their age-matched controls, tended to orient visually toward their repetitive behavior. Similarly, those with disabilities tended to exhibited behavior that involved gross motor movements (e.g., flapping of an arm) and, thereby, were "easy" for an observer to detect (as determined by subjective ratings on a Likert scale). Furthermore, the behavior of individuals with disabilities remained relatively stable across four stimulus conditions, whereas behavior of the age-matched controls appeared to be sensitive to competing forms of stimulation.

The results of Smith and Van Houten (1996) suggest some important considerations for the refinement of the conventional stereotypy definition. The most relevant of these considerations is the use of behavior repetition or rhythmicity to identify the behavior disorder. Nearly every participant exhibited some topography of behavior that was repetitive. Smith and Van Houten's results further suggest that previously neglected

qualitative dimensions may be of greater importance in determining whether repetitive behavior should be considered aberrant. Conversely, in diametric opposition to the outcome from the Newell et al. (1999) study, the results from the Smith and Van Houten (1996) investigation support the utility of "invariance" and "immutability across changing environments" as defining characteristics.

More recently, Ross et al. (1998) challenged the use of rhythmicity as a defining characteristic of stereotypy claiming that the term "periodicity" is a more appropriate descriptor of the temporal regularity. According to Ross et al., periodicity connotes that behavior occurs at fixed points or intervals in time. The interval of time between successive responses is, therefore, a "period." The authors thus argue that in order to demonstrate that a behavior is periodic, it is necessary to evaluate the extent to which the period of time between occurrences is regular. Based on this refined criterion of periodicity, Ross et al. emphasized that notably few studies have demonstrated periodicity in human stereotypy. Successful demonstrations of periodicity have been limited to a single topography, body-rocking.

Based on a refined description of periodicity, Ross et al. (1998) conducted "spectral analyses" of various repetitive behaviors, including body rocking, head rocking, eye poking, hand clapping, and hand mouthing. Data on each participant's behavior were collected using a computer-based collection system equipped with real-time recording. As an assessment tool, spectral analysis essentially enhances the visibility of interresponse times (IRTs) using statistical corrections. Once plotted, data obtained from this method are subjected to visual analyses. Logarithmic graphs containing periodic behaviors show sharp peaks at various points in the sequence, while sequences of random

patterns of behavior appear as a flat line along the x-axis. Ross et al. found that only body rocking produced a periodic component. In light of this outcome, Ross et al. contend that describing "stereotypies" as rhythmic (or periodic) behaviors may be inaccurate and, therefore, the descriptor may insufficiently categorize response forms commonly called stereotypy.

Prevalence

Prevalence statistics for specific topographies of stereotypy, as well as for stereotypy as a broad behavioral category, generally have been derived from indirect assessments. To this end, institutional staff, parents, and teachers have typically served as informants on the occurrence of stereotypies for relevant populations (e.g., children with mental retardation). Several problems arise from this methodology. First, the validity of indirect assessment to obtain prevalence estimates is questionable. Second, survey researchers have historically used weak definitions of stereotypy in comparison to researchers using direct-observation. Third, some researchers subsume the usually recognized category of "nervous habits" into the class of stereotypy (see Miltenberger, Fuqua, & Woods, 1998). Additionally, some researchers use the terms "stereotypy" and "habits" interchangeably, use "habit" to describe behavior of individuals with typical developmental functioning and "stereotypy" for the behavior of individuals with disabilities, or both.

Despite the limitations inherent in prevalence studies of stereotypy, several studies have yielded interesting outcomes. Troster, Brambring, and Beelman (1991) surveyed parents who had children aged 10 months to 6 years who were visually impaired. The survey consisted of questions intended to gauge the relative frequency (e.g., hourly, daily, weekly) of repetitive behavior and the environmental/stimulus conditions (e.g., when child was alone, when child was bored) under which parents observed or did not observe

the behavior of interest. In addition, informants responded to questions regarding the nature of the child's impairment (e.g., retinal disorder, deformity of the eye, disorder of optic nerve). As noted by Troster et al., an individual who has a visual impairment resulting from a retinal disorder can perceive light changes by pressing on the eye. Conversely, such stimulation cannot be produced for individuals whose blindness is caused by an optic nerve disorder.

The overall results indicated that the most prevalent repetitive behaviors observed by parents were eye-poking and body-rocking. Specifically, 19% of parents reported that their child engaged in eye-poking almost hourly, 60% daily, and 78% on a weekly basis. Fifty-eight percent of the parents whose child engaged in the behavior at least weekly indicated that they believed that their child engaged in the behavior when "bored." This information may be useful in identifying a possible operant function for the child's stereotypy. However, it is unclear what method parents used to formulate their postulations about their child's motivation for engaging in the behavior of interest. For example, the parent may have simply assumed the child was "bored" because he was engaged in eye-poking. Thus, even though such information may be useful as a precursor to identifying variables to manipulate experimentally, inferences about internal stimulus conditions, such as "excitement" or "boredom," should be viewed with caution.

Although the data collected by Troster et al. (1991) were obtained from indirect sources, the results raise some interesting questions regarding the categorization of stereotyped behavior. In the absence of data pertaining to measurable dimensions of behavior (e.g., duration, IRTs) it is questionable whether behavior that occurs only on

weekly basis should be regarded as "stereotyped" simply based on topographical distinctions.

In another study, Troster (1994) surveyed caregivers of residential care facilities in an attempt to identify the prevalence of stereotyped behaviors in developmentally typical children. As with the previous study, Troster asked questions about the frequency of repetitive behaviors and the putative conditions under which these behaviors were observed. The results indicated that the most prevalent forms of "stereotypy" for children aged 10 months to 3 years were thumbsucking (72%), hair twisting/manipulation (22%), and body rocking (22%). Thumbsucking remained the most common stereotypy for children aged 3 to 5 years (26%) whereas the most prevalent repetitive behavior in children 6 to 11 years old was nail biting/chewing (17%). Although these behaviors were reported to occur during many stimulus conditions, responders indicated that these behaviors were observed most often when the child was either "tired" (56%) or "bored" (49%). This method of evaluating motivation for behavior is subject to the same criticisms as Troster et al. (1991).

The Troster (1994) study represents an interesting cross-sectional investigation of the prevalence of repetitive behaviors across three arbitrarily designated age categories. This investigation included the study of repetitive behavior in developmentally typical children and an expanded range of the behaviors within the rubric of "stereotypy." Interestingly, the behavior of non-disabled individuals is rarely called "stereotyped," with the noteworthy exception of body rocking. By including behaviors such as thumbsucking and nail biting, Troster deviated from the literature on the dimension of rhythimicity (as

alluded to by Berkson [1983]), and in the extension of the classification of stereotypy to describe developmentally typical behaviors.

Gutermuth-Foster (1998) conducted interviews with the parents and teachers of children aged 3 to 6 years to obtain data on the prevalence of repetitive behaviors. Similar to Troster (1994), Gutermuth-Foster expanded the use of the descriptive term "stereotypy" to behaviors often categorized as "nervous habits," such as thumb-sucking, nail-biting, and hair-twirling and also asked respondents about conditions during which stereotyped behavior occurred. The results of this study indicated that thumb-sucking and nail-biting were the most common behaviors observed with a prevalence of 25% and 23%, respectively. These results were consistent with those of Troster et al. (1991) for this age range; however, respondents reported that behavior was exhibited most often when the child experienced a negative mood (e.g., anxiety) during structured situations (e.g., playtime, instructional activities).

Based on these findings, Gutermuth-Foster (1998) suggested a separate category for "nervous habits," into which thumb-sucking would be placed. Nonetheless, as with data obtained by Troster (1994), the extent to which one can determine an individual's mood or another private event based on overt observations of behavior is questionable. Moreover, prevalence data notwithstanding, neither antecedents nor consequences were systematically manipulated in these studies. In fact, the mention of consequences maintaining stereotypic behavior is notably absent in both studies. Troster (1994) refer to "conditions eliciting stereotypy," but then describes such conditions in terms that are loosely associated with operant behavior (e.g., child "wanting" to gain attention).

Berkson and colleagues conducted a series of studies to identify the prevalence, as well as various behavioral dimensions, of body-rocking in young children and college students (Berkson, Tupa, & Sherman, 2001; Rafaeli-Mor, Foster, & Berkson, 1999). Citing a need for early identification of stereotyped behavior, Berkson et al. (2001) conducted observations of 39 children who were 40 months of age or younger to screen for the presence or absence of various repetitive behaviors (e.g., body-rocking, head-banging, self-scratching). Of particular interest, Berkson et al. found that 33 of the 39 children (nearly 85%) engaged in body-rocking while positioned in one or more body postures (i.e., supine, 4-point, seated, or standing). Berkson et al. suggested that the exhibition of body-rocking from multiple bodily postures may represent a challenge to the notion that body-rocking is function of a unitary mechanism.

To date, the Berkson et al. (2001) study represents one of the most comprehensive studies of early development of stereotypy. It included both parent interviews and videotaped observations of each child's behavior (i.e., direct observation), the results of which were generally consistent. Despite these positive features, the results from the Berkson et al. study may be limited in that observers merely indicated whether each repetitive behavior was present or absent for each child, response definitions for stereotyped behaviors were not clear in terms of time allocation and frequency of each response, and observations of each child's behavior were conducted during a single 5-min session.

Using indirect behavioral measures (i.e., questionnaires), Rafaeli-Mor et al. (1999) found that nearly 15% of a sample of college-aged adults reported to have engaged in body-rocking during a previous two-week period. By contrast, in a sample of adults with

developmental disabilities, Rojahn (1986) found that approximately 44% engaged in body-rocking. Berkson, Rafaeli-Mor, and Tarnovsky (1999) stressed that despite the similarity in classification, the rocking exhibited by individuals with developmental disabilities did not differ significantly from that of typically functioning adults in terms of bout duration; however, rocking of individuals with developmental disabilities was exhibited with greater amplitude (i.e., forward to backward movement), within "inappropriate" contexts, and in conjunction with various other repetitive behaviors (e.g., hand movements). Berkson et al. noted that the discrepancies in body-rocking prevalence across these studies could be attributable to differences in assessment methods and behavioral definitions.

Rojahn (1986) conducted what may be the most extensive survey of prevalence of self-injurious behavior (SIB) and stereotypic behavior in non-institutionalized individuals diagnosed with DD. Based on a sample of nearly 29,000 individuals from nearly 300 service facilities, Rojahn found that approximately 1.7% of the sample exhibited at least one topography of SIB. Moreover, of central relevance for this review, 65% of those who exhibited SIB also displayed one or more topographies of stereotypy. This result initially appeared to confirm prior hypotheses about the possible progression of relatively benign stereotypy to more destructive behavior (e.g., Cataldo & Harris, 1982). However, examination of a control group containing individuals who did not engage in SIB produced a very similar prevalence value. Thus, support for the developmental perspective/progression of stereotypy to SIB was not generated.

It is interesting to note that Rojahn (1986) included behaviors topographically defined as "self-restraint" within the category of stereotypy. Given that self-restraint most often

characterizes behavior that is non-rhythmical and non-repetitive (though arguably immutable), inclusion of this response category represents a significant departure from previous studies. Although data from a recent study suggest that self-restraint may be reinforced by sensory stimulation and could occur independent of SIB (see Rapp & Miltenberger, 2000), most if not all studies suggest that self-restraint and SIB are functionally related (e.g., Fisher & Iwata, 1996). In most cases, the topography of self-injury involves the same body part(s) as the self-restraint. Based on Rojahn's definition of self-restraint, topographies involving other limbs (e.g., legs) or inanimate objects (e.g., wrapping of arms around a chair) may not have been detected and documented. In fact, Fisher and Iwata (1996) reported that no published study has described the occurrence of self-restraint in an individual who did not have a history of SIB.

Berkson and Andriacchi (2000) conducted a multi-phase study to evaluate relative preferences for a rocking chair, stationary chair, and an alternative chair or couch for developmentally disabled adults. The authors hypothesized that body-rocking in a stationary/stable chair and in a rocking chair may provide a similar quality of stimulation (reinforcement). In this same vein, the authors further speculated that the amplitude of rocking in a rocking chair might be easier to regulate and may appear more normal than rocking in a stationary chair. Preference for each chair was assessed via time allocated to each stimulus. Statistical analyses of mean time allocated to each chair indicated no significant difference for chair preference across the group. However, the authors anecdotally noted that specific individuals typically sat in specific seats, thereby suggesting that preference may have been more adequately evaluated separately for each participant with a single-subject design.

In a subsequent phase, Berkson and Andriacchi (2000) utilized a concurrent operants arrangement to evaluate relative preferences of 21 typically functioning college students (identified in Rafaeli-Mor et al. [1999]) and 15 individuals with DD for a rocking chair and stationary chair. Using a between subjects design, the results indicated that individuals with DD engaged in significantly more body-rocking on the dimensions of rate, duration, and amplitude than typically functioning adults. Although data on behavior dimensions were not reported for individual participants, the authors indicated that most of the typically functioning adults chose the rocking chair and engaged in some level of rocking. Conversely, the few who chose the stationary chair never engaged in rocking. By contrast, individuals with DD engaged in body-rocking in either chair. The authors also noted that individuals in both groups typically exhibited other topographies of repetitive behavior while engaged in body-rocking; however, the final phase of the study showed that many of these behaviors exhibited by individuals in the DD group also occurred during periods when body-rocking was absent. The occurrence of other repetitive behaviors in the presence or absence of body rocking may be pertinent in terms of social acceptability (e.g., Jones, Wint, & Ellis, 1990). As suggested by the authors, body rocking exhibited by individuals with DD may be more salient to observers in the environment due to the duration and amplitude. Likewise, it may be that additional repetitive responses increase the salience of body rocking by these individuals.

The study by Berkson and Andriacchi (2000) provides useful information about repetitive behavior in normally developing individuals and may provide some clues about potential operant mechanisms (e.g., positive reinforcement in the form of sensory

stimulation). Collectively, these studies provide a foundation for re-examination of the defining features of stereotyped behavior in humans.

Conclusions about Stereotypy as a Descriptor

The current status of the literature provides a rather equivocal picture of what constitutes "stereotyped" behavior. In a general sense, researchers tend to agree that stereotyped behavior lacks a clear social function. In addition, there is some consensus that elements of repetition and invariance are necessary dimensions; however, there is ambiguity about how many and of what duration a behavior bout (occurrence) must be to constitute "invariance." Similarly, some researchers have extended the use of the term "stereotypy" to behaviors that appear to be invariant, but that obviously lack dimensions of repetition. For example, behavior such as self-restraint and thumb sucking may be invariant; however, continuous and repetitive body movement is not necessary to engage in these behaviors. Therefore, classifying behavior as stereotyped based merely on topographical invariance may be too lenient.

As it pertains to invariance, the context in which repetitive behavior is exhibited and the salience of the response are contributing factors in determining whether behavior should be deemed problematic. Despite the fact that typically functioning adults engage in numerous forms of repetitive behavior, the literature suggests that repetitive behavior that is exhibited by individuals with DD is often displayed across a variety of stimulus contexts, occurs in conjunction with multiple repetitive response forms, and is highly salient to others in the environment. The apparent insensitivity to potentially competing social variables appears to be an important distinction between behaviors that are merely repetitive in nature and those that are deemed stereotyped.

For the series of studies that are described in subsequent chapters, I have adopted the characteristics of movement invariance and movement repetition as primary criteria for categorizing stereotyped behavior. Similarly, the focus of these studies was on stereotyped behavior that persisted in the absence of social consequences. The use of these criteria did not exclude the study of behavior shown to be multiply controlled (i.e., maintained by nonsocial and social sources of reinforcement). Likewise, in cases where an individual exhibited multiple forms of repetitive behavior, some of which may not have met the present definition of stereotypy (e.g., thumbsucking, bruxing), the non-stereotyped behaviors were included in the analysis as long as each persisted without social reinforcement.

Review of Response Restriction Analysis

The response deprivation model has been used to evaluate how individuals with DD allocate responding during free and restricted operant conditions (e.g., Green & Striefel, 1988; Hanley, Iwata, Roscoe, Thompson, & Lindberg, 2002; McEntee & Saunders, 1997). Following a brief discussion of these converging literatures in the present chapter, the ensuing chapters provide a series of studies that expand the application of response restriction analyses to the treatment of stereotypy. More specifically, a conceptual model for the analyses of the effects of behavioral interventions on automatically reinforced stereotypy will be developed and explained.

Concurrent Operants Analysis

In an attempt to make an a priori identification of the necessary and sufficient conditions for "reinforcement," Premack (1959) inductively arrived upon the "probability differential" hypothesis, which specified that "…any response A will reinforce any other response B, if and only if the independent rate of A is greater than that of B" (Premack,

1959, p. 220). The outcome of a preparation involving two such responses would be an increase in the instrumental response and a decrease or suppression of the contingent response. Timberlake and Allison (1974) proposed the "response deprivation" hypothesis to account for changes in response allocation based on restricting any response below free operant levels. Even if a relatively low probability response was restricted below its baseline level of allocation, it could serve as a reinforcer if made contingent upon another response. Klatt and Morris (2001) recently revisited the issue of response deprivation/restriction with particular concern for the evocative effects of response deprivation. Specifically, Klatt and Morris argued that response deprivation and response restriction function as an EO because the effectiveness of the contingent event as reinforcement may be altered as a function of withholding a response. Further, the authors speculated that increasing an instrumental response above its free operant baseline levels might produce "response satiation" and thereby establish that response as aversive.

The validity of the response deprivation hypothesis for predicting behavior change within a concurrent operants arrangement has been well supported by research with both humans and nonhumans. Konarski and colleagues conducted a series of studies involving academic tasks for children and leisure activities for individuals with DD (e.g., Konarski, 1987; Konarski, Johnson, Crowell, & Whitman, 1980). In a two-part investigation involving a concurrent operants preparation, Konarski et al. (1980) first demonstrated that contingent access to a low probability response that was restricted below its free operant levels functioned as reinforcement (i.e., produced a slight increase) for a high probability response. In a second experiment, Konarski reversed both the restriction and

the contingency to produce increases in the low probability response, thereby directly demonstrating the "Premack" effect. Thus, Konarski concluded that response deprivation was a sufficient and necessary condition for producing change in response allocation. These results were replicated in a subsequent group-design study (Konarski, 1987). It should be noted that even though both studies employed conditions that provided FT access to the contingent response (to control deprivation levels), neither study equivocally ruled-out the possibility that behavior reallocation occurred as an artifact of increased opportunity, rather than a reinforcement effect via contingent access. To some extent, this matter was addressed in other investigations.

Premack (1965) utilized a concurrent-operants arrangement to demonstrate that restricted access to drinking for rats did not produce increased wheel running without an additional contingency: Premack concluded that subsequent increases in the instrumental response were the product of the arranged contingency and not simply increased opportunity. Nevertheless, several studies have shown that restriction of one of any pair of responses increased the remaining available response in the absence of a programmed contingency (e.g., Allison & Timberlake, 1974; Dunham, 1972). In short, the disparate results from these studies suggest the paired-operants preparation may not be appropriate for evaluating the effects of restricted access and/or response deprivation on other behavior.

To address the aforementioned procedural limitation, researchers employed a preparation involving a multiple response repertoire, wherein at least one response, in addition to the instrumental and contingent responses, was made available. Diorio and Konarski (1989) utilized this approach in conjunction with noncontingent schedules (a

massed reinforcement condition) to evaluate the effects of a contingent response on the instrumental responding of individuals with DD. Following a baseline condition from which the instrumental response, free or alternative response, and contingent response were derived (based on allocation time), schedules that involved a contingency showed that response deprivation produced greater increases in the instrumental response than in the alternative response. Conversely, schedules containing massed reinforcement (yoked FT presentation of the contingent response) produced the highest occurrence of the alternative response. Thus, Diorio and Konarski concluded that behavior change within such a context is determined both by the contingency and the availability of alternative responses.

Multiple Operants Analysis

In a study of typically developed adults, Bernstein and Ebbesen (1978) examined the effects of multiple alternative responses during conditions where a high probability response was merely restricted or made contingent on a low probability response. The results showed that free operant levels of human activities (e.g., reading, sewing) were altered by arranging access to one activity contingent on another; however, the data also showed that restriction of one response often resulted in substitution of an alternative response (i.e., no change in the instrumental response). From the latter outcome, it was presumed that deprivation for the contingent response was not established because the alternative response(s) provided reinforcement that was substitutable for reinforcement that was restricted. Of broader conceptual relevance, results of this study suggest that increases in alternative responses (i.e., expansion of a repertoire) may occur as a function of restricting a high probability response. This observation has important ramifications for the treatment of stereotypy in individuals with DD.

Using multiple response environments, the effects of restricted responding without an instrumental response have been evaluated in several studies with nonhumans. For example, Dunham and Grantmyre (1982) examined response reallocation in gerbils under conditions where access to eating was either restricted or followed by aversive stimulation (i.e., punished). In general, Dunham and Grantmyre found that restricting eating (third most probable response based on free operant observations) via punishment or unavailability actually produced reductions in non-targeted "digging" (second most probable response) and slight increases in running (the most probable response). Subsequently, Dunham and Grantmyre restricted access to digging (i.e., removed the sandbox) and found that running increased while eating was unchanged. Based on these outcomes, the authors concluded that during conditions of response restriction, the most probable remaining response increases to consume uncommitted time that was made available by the restriction (in this case, wheel running). More specifically, the authors hypothesized that certain behaviors may occur in a temporal order such that one may be sequentially dependent upon the other. Removal of one response reduces the frequency of the other response. Thus, digging reduced when the opportunity to eat was restricted, presumably because digging typically followed food ingestion. Conversely, "digging" restriction did not alter levels of food ingestion but did produce a slight increase in wheel run (the most probable response).

Although it can be argued that the behavioral relationships observed in the Dunham and Grantmyre (1982) study are "species specific" and therefore are of limited generality, the response patterns are of conceptual and applied interest for at least two reasons. First, neither the "rate differential" nor the "response deprivation" model of response allocation

model accurately predicted the response allocation for each organism. For example, the response deprivation hypothesis predicts that if eating were restricted below free operant levels, contingent access to eating would reinforce digging; however, Dunham and Grantmyre's data do not support this prediction. It is possible that the phenomenon of sequential dependency represents a unique set of motivational operations wherein engagement in one behavior sets the occasion for another response to function as reinforcement (see Klatt & Morris, 2001). Second, the data from Dunham and Grantmyre suggest that restricting access to one behavior can increase the probability of one response and simultaneously decrease the probability of another. This outcome could have direct relevance to automatically reinforced aberrant behavior (e.g., stereotypy) insofar as treatment of one behavior may reduce another behavior or possibly increase an even less desirable behavior. Preliminary data on the possible effects of "sequential dependency" in clinical applications may be evident in a study by Friman and Hove (1988), who found that suppression of thumb sucking (a high probability response) using a punishment procedure also eliminated hair pulling (a low probability response).

Lyons and Cheney (1984) studied behavior allocation of rats in a multiple-response environment that contained five compartments. In each compartment a distinct response was available and was measured (e.g., access to water, opportunity to view a female rat). Within this closed system of responses, Lyons and Cheney evaluated the effects of eliminating either the high or low probability response. Although between subjects response allocation was quite consistent during free operant, restriction of the high and low probability response produced idiosyncratic reallocation patterns. From these results, Lyons and Cheney concluded that no single rule for response reallocation (e.g.,

sequential dependency, selective substitution) adequately predicted behavior change during restriction of either the high or low probability responses.

It is worth noting that the Lyons and Cheney (1984) study differed from the Dunham and Grantmyre (1982) study in at least three important ways. First, Lyons and Cheney intentionally selected behaviors that involved distinct sensory modalities and potentially distinct operant and/or respondent functions. Similarly, although the separation of responses according to compartments may have enhanced behavioral measurement, it may have inadvertently imposed a temporal separation between any two responses (i.e., obscuring sequential relations). Second, sessions in the Lyon and Cheney study were of substantially greater length than in the Dunham and Grantmyre study; differences in the behavior patterns between the two studies may be the result of parameter specific effects. Third, unlike Dunham and Grantmyre, Lyons and Cheney did not conduct within-subject replication of response allocation patterns during either restriction condition. Given that a high degree of between-subjects variability was observed during the restriction conditions, it would have been informative to replicate each condition to evaluate within-subject effects.

Several studies have utilized a response restriction (RR) approach to analyze behavior allocation of individuals with DD. Rather than creating a contingency between two behaviors, researchers evaluated response reallocation in multiple-response environments under conditions when the most probable response was restricted (Green & Striefel, 1988; Hanley et al., 2002; McEntee & Saunders, 1987). Following RR, response reallocation was observed and the most probable response that emerged during RR was

then restricted. This process was then repeated in a diminishing fashion until one or two responses was/were available.

Using the RR approach, Green and Striefel (1988) restricted access from five activities to one for four children with autism. Specifically, the authors were interested in the extent to which reallocation of responding under conditions of restriction involved "selective substitution" (i.e., reallocation of available time to primarily one activity/response). In general, the results from Green and Striefel showed that restriction of the most probable response increased allocation to multiple activities, thereby providing minimal support for a "selective substitution" prediction. McEntee and Saunders (1997) conducted a procedural replication of Green and Streifel's (1988) study in their analysis of stereotypy and unstructured leisure activity. As in the previous study, McEntee and Saunders (1997) found also that reallocation under diminishing alternatives produced idiosyncratic response patterns; however, one specific activity typically increased during each successive restriction for each participant. More importantly, behavior in a category labeled as "other," which included stereotypy, increased across each successive restriction. Thus, these studies provide some insight as to the conditions under which individuals allocate responding to stereotypy, appropriate alternatives, or both. As an extension of the aforementioned results, it would be conceptually interesting and pragmatically valuable to empirically determine the number of restrictions (i.e., how many behaviors must be treated) that are necessary to facilitate reallocation to appropriate responding (e.g., toy play, peer interaction).

Response Restriction and Preference

Hanley et al. (2002) conducted a multiphase evaluation of individuals' preference for activities during free operant and (RR) stimulus preference assessments. In these

analyses, Hanley et al. used a combination of free operant stimulus preference assessment (for leisure activities) and RR procedures, whereby stimuli identified as preferred were restricted in a diminishing fashion and preference was re-evaluated following each restriction. Hanley et al. also evaluated possible changes in preference as a function of providing reinforcement for engagement in "low preference" activities.

The results showed that participants generally reallocated behavior to a specific alternative activity under conditions where the previously identified preferred activity was restricted. Further, when results from the RR evaluation were compared to those obtained during extended free operant assessments (e.g., 80 min in duration), the former showed that every activity in the array supported some level of behavior (depending on the level of restriction), whereas the latter did not (i.e., some items were not manipulated). Subsequently, for two participants with whom restrictions did not occasion increased allocation to low probability activities, Hanley et al. found that additional reinforcement altered preference for that activity; however, when reinforcement was discontinued the individuals reallocated responding to the previously preferred activity. Last, Hanley et al. provided reinforcement (e.g., snacks) on FT schedules when a less preferred activity was available. The results showed that additional reinforcement altered preference during periods when the reinforcement was removed and that these changes were enduring for some participants.

Treatment of Stereotypy

Several prescribed treatments for stereotypy inherently involve restriction of a response (and its consequence) within a multiple response repertoire. Stereotypy is typically the restricted response (e.g., treatment is intended to suppress the behavior), while other responses are available. Some early studies involving response blocking of

stereotypy found that restricting access to stereotypy actually produced subsequent increases in problematic behavior. In a series of studies, Baumeister and Forehand (1971) and Forehand and Baumeister (1971; 1973) examined body rocking that was exhibited by individuals with DD. After establishing free operant levels of six individuals' body rocking, Forehand and Baumeister (1973) evaluated the changes in subsequent levels of body rocking as a function of physically restricting body movement prior to behavioral observations. The results showed that levels of body rocking were higher following periods where movement was restricted.

Baumeister and Forehand (1971) and Forehand and Baumeister (1971) evaluated changes in body rocking during conditions where a previously reinforced instrumental or "goal directed" response was placed on extinction. Results from both studies showed that body rocking increased above baseline levels during extinction of the instrumental response. The authors speculated that disruption of "goal directed" behavior had produced "frustration," which occasioned increased levels of stereotypic body rocking. However, this account requires a mediating variable (i.e., frustration) that is inferred from increased body rocking.

Alternatively, it seems that behavior changes observed in the Baumeister and Forehand studies are explainable in terms of the response deprivation hypothesis. In each study, access to free operant levels of stereotypy was restricted via physical immobilization or by providing additional reinforcement for allocating responding to a competing operant. Thus, it is possible that both preparations produced deprivation from the reinforcing products of body rocking, thereby increasing the future probability of that response (see Klatt & Morris, 2001). Previous studies, which restricted access to a high

probability response, showed that when a restricted response is again permitted, it occurs at higher levels than it did during the initial free operant baseline (e.g., Bernstein & Ebbesen 1978, McIntee & Saunders, 1997), suggesting that deprivation was a likely product of the restriction.

The importance of evaluating multiple responses is exemplified in cases when an individual exhibits several aberrant topographies of problem behavior, which may or may not be members of the same functional class. Based on a homeostatic hypothesis, Repp, Karsh, Deitz, and Singh (1992) and others (e.g., Guess & Carr, 1991) have argued that individuals who exhibit stereotypic behavior maintain relatively constant levels of motoric responding across extensive periods of times. The homeostasis hypothesis predicts that a reduction in one motoric response will produce in an increase in another motoric response in order to maintain an optimum level of responding. Results from several studies are unclear, but they do suggest that this position may warrant further investigation.

For example, Rollings, Rollings, and Baumeister (1977) used overcorrection to treat body rocking that was exhibited by an individual with DD. Implementation of the intervention was marked by a gradual reduction in body rocking and a simultaneous but gradual increase in another repetitive behavior. Rollings and Baumeister (1981) produced a similar outcome using gradients of a stimulus that was correlated with punishment (i.e., inhibitory stimulus control). More specifically, Rollings and Baumeister showed that target responses were suppressed in the presence of an inhibitory stimulus, while alternative responses (e.g., head movements, vocalizations) increased above free operant levels. By contrast, behavior allocation returned to baseline levels in the presence of a

stimulus (safety signal) that was not correlated with punishment. The patterns of behavior allocation in the studies by Rollings and colleagues are interesting because restriction of the target response was necessary to occasion greater variability in the respective individual's repertoire. To account for this outcome, Rollings and Baumeister (1981) proposed that stereotypic behavior occurred in a hierarchical manner such that lower-ranked responses were exhibited only when current responses became unavailable.

More recently, Hanley, Iwata, and Lindberg (1999) used a traditional instrumental-response preparation to evaluate the effects of providing access to stereotypy contingent on appropriate behavior (e.g., object manipulation). For one participant, Hanley et al. found that mere restriction of stereotypy during an enriched environment occasioned appropriate object interaction; however, when the restriction was removed the individual reallocated responding to stereotypy. Hence, as a whole, several studies have shown that treatment for stereotypy produced increases in other repetitive behavior (Johnson, Baumeister, Penland, & Inwald, 1982; Rollings & Baumeister, 1981; Rollings et al., 1977) or appropriate behavior (Hanley et al., 1999). It is not clear, however, under what restriction conditions behavior reallocation to appropriate or stereotypic alternatives will occur. Moreover, if behavior reallocation during response restriction can be predicted, can it likewise be altered to increase the probability that appropriate behavior will increase.

CHAPTER 2
GENERAL METHOD

Based on the outcomes of traditional treatment studies (Johnson et al., 1982; Rollings & Baumeister, 1981; Rollings et al., 1977) and, more recently, from stimulus preference assessments (SPA) involving free operant (Ringdahl, Vollmer, Marcus, & Roane, 1997; Roane, Vollmer, Ringdahl, & Marcus, 1998), multiple stimulus without replacement (DeLeon & Iwata, 1996), and response restriction (RR: Green & Streifel, 1988; Hanley et al., 1999; Hanley, Iwata, Roscoe, Thompson, & Lindberg, 2002; McIntee & Saunders, 1997) procedures, it is reasonable to assume that individuals may indeed exhibit hierarchies for automatically reinforced behaviors (see Rollings & Baumeister, 1981).

A potential shortcoming of many of the aforementioned studies is that the use of a limited number of operants (e.g., SPAs typically include 5 to 10 items) and the use of an "other" category into which unspecified behaviors were placed may have obscured measurement of pure allocation patterns (Green & Striefel, 1988; McIntee & Saunders, 1997). The mere discussion of response hierarchies implies that a given individual's repertoire contains numerous responses. Consistent with this assumption, a further implication is that treatment of problematic, yet highly preferred, behavior that is exhibited by an individual may produce increases in formerly less frequent and less problematic behavior. Because many individuals who exhibit stereotypy often engage in multiple topographies of problematic behavior, but display disproportionately low levels of appropriate behavior, it may be useful to examine response reallocation (within

multiresponse repertoires) as a function of treating (restricting) high probability problem behavior.

To address the question posed above, behavior allocation would first need to be evaluated under free operant conditions. Presumably, the aberrant behavior (i.e., a topography of stereotypy) to which the most responding was allocated would be deemed most problematic and therefore targeted for intervention. Behavior allocation would then be re-evaluated during and following restriction of the targeted response. Depending on the explicit goal of the intervention, this method might also be conducted in the presence or absence of competing stimuli (an enriched environment). Using an appropriate experimental design, RR analyses could potentially predict how an individual will reallocate responding in the absence of the target behavior. Several permutations of allocation could arise following treatment. For example, the individual may allocate responding to toy manipulation, which may result in sustained contact with a novel and potentially competing source of stimulation (reinforcement). Conversely, restriction of a problematic behavior could be followed by reallocation to a response that is less desirable than one initially targeted for intervention (e.g., SIB). The former outcome is desirable whereas the latter outcome obviously warrants further intervention or suggests that the original intervention is contraindicated.

Based on the extant literature involving response restriction, a series of studies was conducted to evaluate behavior reallocation under conditions of stereotypy treatment/restriction. Individuals who exhibited three or more forms of stereotypic behavior participated in one to three studies. Some researchers have established relative response hierarchies or stimulus preferences based on the amount of time an individual

allocates to each of a fixed number of responses, items, or both (Ringdahl et al., 1997; Roane et al., 1998). In this way, a response to which an individual allocated the most time during a free operant evaluation could be denoted R^1, the second most time as R^2, and so on (see Dunham & Grantmyre, 1982). Following baseline assessments of response allocation, three experiments were conducted to assess allocation of stereotypic and other behavior (e.g., toy play) under conditions where: 1) access to R^1 was restricted; 2) the environment was enriched with potentially competing sources of reinforcement; and 3) environmental enrichment (EE) did not facilitate allocation to appropriate behavior (i.e., R^1 must be restricted during EE or differential reinforcement is required).

Method and Procedures

Five children with varying levels of developmental disabilities participated in one to three of the four studies described below. To participate in these studies, each individual must have exhibited at least three topographies of stereotypy. A behavior was categorized as "stereotypy" if it occurred in bouts of three or more body movement repetitions (e.g., hand flapping, body rocking) or was invariant for three or more seconds (e.g., vocalizations, mouthing). To be included in the analyses, the response forms in question must have persisted during conditions when no social reinforcement was provided. Behaviors that persisted without social reinforcement, but were not stereotyped by definition (e.g., thumbsucking) or were maintained by both social and nonsocial sources of reinforcement (e.g., repetitive hand biting maintained by automatic and tangible reinforcement), were also included in the analyses.

Participants

Mike was an 8-year-old boy diagnosed with autism. He exhibited hand mouthing, pacing, ear covering, and hand biting. *Mary* was a 5-year-old girl diagnosed with autism.

She exhibited pacing, ear-covering, object spinning (specifically, a pot lid), hand flapping, carpet rubbing, mirror viewing (with body movements), and object flicking. *Geff* was a 14-year-old boy diagnosed with Down syndrome and severe mental retardation. Geff engaged in body rocking, groin rubbing, hand rubbing, hand flapping, head rubbing, chin hitting, head hitting, snorting, tooth grinding, repetitive vocalizations, and object pounding. *Alice* was a 10-year-old girl diagnosed with childhood disintegrative disorder. She displayed pacing, repetitive vocalizations, carpet rubbing, and clothing manipulation (e.g., tugging on shoe laces). *Greg* was a 10-year-old boy diagnosed with autism. He engaged in thumb sucking, repetitive vocalizations, mirror viewing, pacing, jumping, and object pounding. In terms of the order of the experiments, some individual participated in experiment 3 before participating in experiment 1. Table 2-1 lists the response forms and the respective response definitions for each participant, as well as the experiment(s) in which each participated.

Settings

All sessions for Mike, Geff, and Alice were 10 minutes in duration and took place in an 8 ft x 12 ft room within an inpatient hospital setting. For these three participants, data were collected three days per week and one to three sessions were conducted each day. Data for Geff's behavior were collected at his school in a 9 ft x 12 ft area of a room that was bordered by tables. For Greg, two to three sessions, 10 minutes in duration, were conducted 4 days per week. Data for Mary's behavior were first collected at her home and, subsequently at her school (due to relocation of her family). Data were collected three days per week and one 30-minute session was conducted per day. The rooms used for the analysis at Mary's home (i.e., the family room and kitchen) and school were approximately 15 ft x 15 ft and 20 ft x 20 ft, respectively. The family room contained a

sofa, recliner, two tables, one mirror, and a television, which was unplugged. The kitchen was essentially devoid of all stimuli, with the exception of pot lids (see table 2-1). Mary

Table 2-1. Participants' diagnoses and target behaviors

Participant	Diagnosis	Age	Target Behaviors	Experiment in which participant was involved
Mike	Autism	8	hand mouthing; hand flapping; body rocking; hand biting; ear covering; pacing; page turning	1
Mary	Autism	5	pot-lid spinning; object flicking; hand flicking; pacing; body rocking; ear covering; mirror viewing	1
Geff	Downs Syndrome; Severe MR	14	snorting; hand rubbing; vocalizations; body rocking; bruxing; head rubbing; groin rubbing; shirt mouthing; chin hitting; head hitting; brief tearing; object pounding	1 2 3
Alice	Childhood Disintegrative Disorder	10	pacing; clothing manipulation; vocalization; carpet rubbing	1 2 3
Greg	Autism	10	vocalizations; running/pacing; yelling; mirror viewing; surface pounding	2

was free to roam between the two adjacent rooms. The room that was used at Mary's school contained several small tables, a rocking chair, and several computers (none was operational). In addition to differences in relative space, the room at Mary's school contained 3 mirrors. Due to scheduling conflicts at Mary's school, the last 8 sessions were conducted in a room that was approximately 5 ft x 8 ft. In an attempt to hold possible time-of-day variables constant, sessions for each participant were conducted at the same time each day, with the exception of Alice, whose sessions were conducted in either the late morning or early afternoon.

Dependent Variables and Interobserver Agreement

Data for each participant were collected either through direct observation or via videotape using laptop computers that were equipped with a program that recorded instances and duration of each response. Interobserver agreement scores (IOA) were obtained by having a second, independent observer either directly collect data simultaneously or from videotaped sessions, which were scored at a later time. IOA scores were calculated using the average agreement within 10-second intervals method (see Shirley, Iwata, Kahng, Mazeleski, & Lerman, 1997). Due to the large number of response forms exhibited by Geff, two observers were assigned to collect data on only half of the dependent variables during each session (i.e., one individual served as primary observer for six behaviors, the other observer collected data for the remaining six behaviors). To obtain IOA measurements for Geff's behaviors, the observers were randomly assigned to score one or two behaviors, for which the other was the primary observer, during each session. IOA was obtained for at least 25% of sessions (the actual number of sessions varied for each individual according to the studies in which she or he participated) for each behavior across all five participants. Mean IOA scores for each participant's stereotyped response forms are shown in Table 2-2.

Table 2-2. Target Responses and Interobserver Agreement Scores Across Experiments

Participant	Target Behavior	Response Definitions	Mean IOA score	Range of IOA scores
Mike	a) hand mouthing	a) insertion of either hand into past plane of the mouth	a) 86.7%	a) 80.4 % to 100%
	b) hand flapping	b) 2 or more up and down or side to side movement of one or both hands	b) 83.5%	b) 75.3% to 100%
	c) body rocking	c) movement of torso front and back >2 times (standing or sitting)	c) 93.8%	c) 87.6% to 100%
	d) hand biting	d) closure of mouth and contact of teeth with either hand	d) 89.5%	d) 88.9% to 100%
	e) ear covering	e) placement of one or both hands over ear(s)	e) 95.8%	e) 93% to 100%
	f) pacing	f) walking for 2 or > in circles or across a room	f) 97.4%	f) 88.9% to 100%
	g) page turning	g) turning pages of a book or magazine every 3 s or less	g) 94.5%	g) 86.5% to 100%
Mary	h) pot-lid spinning	h) physical contact (e.g., spinning) with and visual orientation to the potlid	h) 96.7%	h) 88% to 100%
	i) object flicking	i) causing motion of an object (e.g., phone cord) with fingers	i) 84.5%	i) 68.9% to 100%
	j) hand flapping	j) see b	j) 88.6%	j) 65.5% to 100%
	k) pacing	k) see f	k) 89.6%	k) 78.5% to 100%
	l) body rocking	l) see c	l) 82.9%	l) 74% to 100%
	m) ear covering	m) see e	m) 93.5%	m) 83.9% to 100%
	n) mirror viewing	n) visually orienting toward mirror	n) 95.6%	n) 85.5% to 100%
Geff	o) snorting	o) inhalation of air that produces a bassy audible product	o) 95.3%	o) 87% to 100%
	p) hand rubbing	p) contact of one hand with the other up to the elbow	p) 93.6%	p) 85.6% to 100%
	q) vocalizations	q) any audible product with open mouth that was not snorting	q) 84.5%	q) 64.9% to 100%
	r) body rocking	r) see c	r) 91.3%	r) 78.2% to 100%
	s) bruxing	s) grinding audible produce with mouth closed	s) 78.1%	s) 56.3% to 100%
	t) head rubbing	t) any contact of a hand with head, excluding head	t) 87.4%	t) 80.2% to 100%
	u) groin rubbing	u) contact with a hand with groin area	u) 95.8%	u) 91.8% to 100%
	v) shirt mouthing	v) placement of shirt between teeth	v) 93.9%	v) 88.3% to 100%
	w) chin hitting	w) forceful contact of a closed fist and open palm with chin	w) 88.8%	w) 79% to 100%
	x) brief tearing	x) tearing of under garment resulting in a torn product	x) 87.2%	x) 82.5% to 100%
	y) object pounding	y) contact with a hand on a surface (e.g., desk, wall)	y) 79.7%	y) 73.9% to 100%
Alice	z) pacing	z) see b	z) 98%	z) 94.6% to 100%
	aa) clothing manipulation	aa) 2 or more finger movements while in contact with an article of clothing (e.g., twisting shirt)	aa) 96.7%	aa) 91.4 to 100%
	bb) vocalizations	bb) any audible product from the mouth	bb) 89.6%	bb) 79.9 to 100%
	cc) carpet rubbing	cc) 2 or more finger movements while in contact with carpet	cc) 92.5%	cc) 86.3 to 100%
Greg	dd) vocalizations	dd) any audible product from mouth that was not yelling	dd) 92.3%	dd) 83.4 to 100%
	ee) pacing/running	ee) see b	ee) 68.7%	ee) 55.2 to 100%
	ff) screaming	ff) audible product from mouth that exceeded normal talking volume	ff) 88.9%	ff) 85.6 to 100%
	gg) mirror viewing	gg) see n	gg) 96.2%	gg) 85.6 to 100%
	hh) object pounding	hh) see y	hh) 92.5%	hh) 84.8 to 100%

CHAPTER 3
RESTRICTION OF HIGH PROBABILITY BEHAVIOR

As previously discussed, many individuals who exhibit stereotypy often engage in multiple topographies of problematic behavior. In addition to high rate and frequency aberrant behavior, these same individuals often display disproportionately low levels of appropriate behavior. From the perspective of prescribing effective intervention for the problem behavior of such individuals, it may be useful to examine response reallocation (within multi-response repertoires) as a function of treating (restricting) high probability problem behavior. To conduct this evaluation, it is first necessary to determine behavior allocation under free operant conditions. Presumably, the aberrant behavior (i.e., a topography of stereotypy) to which the most responding was allocated would be deemed most problematic and therefore targeted for intervention. Behavior allocation would then be re-evaluated during and following restriction of the targeted response.

Several studies have recently shown that use of conditional probabilities (e.g., the availability of a preferred stimulus and the occurrence of a problem behavior) may inform researchers about variables that maintain problem behavior (Mueller, Sterling-Turner, & Scattone, 2001; Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001). To date, no study has used this method to analyze possible relationships between stereotyped behaviors. Moreover, no study has evaluated relationships between stereotyped (i.e., automatically reinforced) behaviors by comparing conditional and unconditional probabilities. The extent to which the occurrence of one stereotyped behavior reliably predicts the occurrence of another stereotyped behavior could yield supplemental support

for data obtained from within-sessions analyses. For example, conditional probabilities can provide information concerning the extent to which; a) a behavior is more likely to occur given the presence of another behavior (i.e., two behaviors occur simultaneously), b) a behavior is unlikely to occur given the presence of another behavior (i.e., an inverse correlation between behaviors), and c) engagement one behavior precedes but terminates prior to engagement in another behavior, (i.e., one behavior possibly sets the occasion for the other).

The purpose of the current experiment was twofold. The primary goal was to determine whether relative preference for stereotypy could be determined and, thereafter, to evaluate the effects of restricting the most preferred response form. In addition, we wanted to evaluate possible relationships between each participant's stereotyped responses using statistical and quantitative analysis.

Methods

Participants

Mike, Geff, Alice, and Mary participated in experiment 1. The settings, target behavior, and data collection were as described in Chapter 2. The effects of the manipulations described below on each participant's repetitive behaviors were evaluated using either an extended or brief (Mike only) reversal design.

Each participant's stereotypy was first evaluated during sessions where the individual was either physically alone (Mike only) or where an experimenter was present, but no social consequences were provided for stereotypy. Sessions were conducted until at least two consecutive sessions revealed a consistent order in time allocation for the most preferred repetitive response (e.g., pacing occurred for the highest percentage of time for a minimum of two consecutive sessions). A maximum of 300 minutes of total

observation was conducted during each baseline or experimental phase in order to determine time allocation for each participant's stereotypy. Note that individual sessions were 10 minutes in duration for every participant except Mary, for whom sessions were 30 minutes in duration (see Chapter 2).

During the course of baseline (described below), each participant's preference for his or her stereotyped behavior was determined by visual inspection of trends in data paths across individual sessions within each phase, the overall average time allocation to each response during each phase, or a combination of both approaches. In general, the results of these approaches yielded the same conclusion regarding preference for a behavior.

Procedures and Design

The effect(s) of the experimental manipulation (i.e., restriction of the most preferred stereotypy) on each participant's behavior was evaluated using an ABAB reversal design where A was the baseline (free operant) condition and B was the experimental (restriction) condition. Preference for a form of stereotypy was determined based on the criteria described above. Subsequent analyses were conducted using statistical and conditional probabilities analyses to further evaluate behavior-behavior relationships. Due to the fact that two separate observers collected data for half of the behaviors exhibited by Geff during each session, we were unable to conduct conditional probabilities analyses with some pairs of behaviors (e.g., hand rubbing and tooth grinding were scored by observers 1 and 2, respectively, and therefore were not a part of the same data file). Data for Mary's stereotyped behaviors were unavailable for quantitative analyses.

During the *Free Operant (FO)* condition (i.e., baseline), each participant was escorted to the setting described above, which was devoid of stimuli that were not related to the

respective individuals' stereotypy. No social consequences were provided during this condition. This condition served as the baseline for the treatment condition(s) described below (and in subsequent experiments).

In the *Restriction of R^1* (R^1) condition, the behavior identified as most preferred (according to the criteria established above) during FO was restricted by either removing the item with which the specific stereotypy was displayed or by providing mild punishment contingent on the occurrence of the stereotypic response. For example, in the case of the former, Mary's most preferred response was pot-lid spinning, which was restricted by removing the pot-lid from the room during sessions. In the case of the latter, both Mike and Alice exhibited pacing as their most preferred response. To restrict pacing, an inhibitory stimulus control procedure was used wherein a mild verbal reprimand (e.g., "no pacing Mike, please sit in the chair") was provided contingent on the initiation of pacing (Patel, Ghezzi, Rapp, O'Flaherty, & Titterington, in press). In addition, a salient stimulus card (i.e., a warning stimulus) was placed on the wall in direct view of the child during this condition. After several presentations of the contingent verbal reprimand in the presence of the card, the use of reprimands was obviated and the card alone was sufficient for maintaining the absence of the target behavior. Thereafter, each participant's behavior was evaluated until preference for another form of stereotypy was determined.

Data that were collected during the Free Operant (FO) and Restriction of R^1 (R^1) were analyzed using Spearmans Rho (r_s), which is a nonparametric statistic used to identify rank-order correlations. For this analysis, rank-order correlations were used as a within-subjects measure of relationships between behavior "ranks" (in terms of time allocation)

across sessions. For example, if an individual exhibited five behaviors during a session, the behavior to which the most time was allocated is ranked "1" and the behavior to which the least time was allocated is ranked "5". The extent to which the relative ranks of the two behaviors remain the same or change across repeated observations (sessions) determines the coefficient of correlation (r_s). Separate analyses were conducted for sessions within the FO and R^1 phases. Behavior relationships that were significantly correlated (positively or negatively; $p < .05$) in the FO, R^1, or both phases, were then evaluated using conditional probabilities. As a general rule, the behavior to which the respective individual allocated more time (of the two response forms that were subjected to analysis) served as the denominator. Using this format, conditional probabilities were calculated for each behavior pair when the behavior that was designated as the denominator was "on" (i.e., already occurring). In the event that an equivalent portion of time was allocated to each stereotyped behavior, the response that was restricted during R^1 was appointed to the denominator position.

Results

Figure 3-1 shows the allocation of Mike's stereotypy (7 topographies; hand mouthing, pacing, ear covering, hand biting, hand flapping, body rocking, and page turning) across the free operant and experimental phases. The top panel of Figure 3-1 shows that during the first FO phase, Mike allocated the highest proportion of time to pacing (see second panel) and hand mouthing (*M*s = 63% and 50.5%, respectively) and substantially less time to other behavior such as ear covering (*M* = 4.5%) and hand flapping (*M* = 2.5%). Based on data obtained during the first FO phase pacing was restricted in the following phase. During the first R^1 phase, pacing rapidly decreased and was eventually

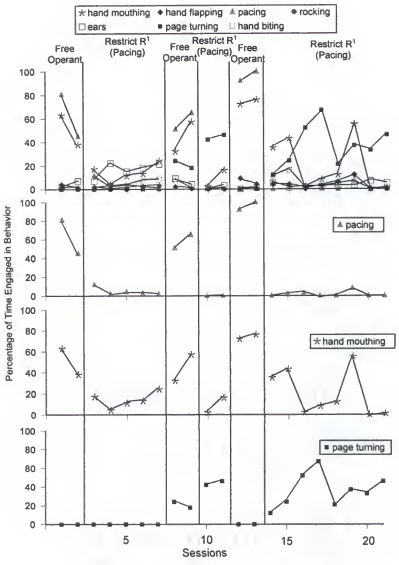


Figure 3-1. Percentage of time Mike allocated to all response forms (first panel), pacing (second panel), hand mouthing (third panel), and page turning (fourth panel) across sessions.

eliminated (M = 4.6%), hand mouthing immediately decreased, but thereafter increased slightly during the last session of this phase (M = 13.8%), and ear covering increased to a stable level (M = 16.6%) for four sessions. In the second FO phase, Mike allocated the highest proportion of time to pacing and hand mouthing (Ms = 58% and 44.5%, respectively) and, unlike the first FO phase, Mike allocated a moderate proportion of time to page turning (M = 21%) and ear covering (M = 6.5%). A return to the R^1 phase

produced substantial decreases in the amount of time allocated to pacing, hand mouthing, ear covering (*M*s = 0, 9%, and 2%, respectively), and an increase in time allocated to page turning (*M* = 44%).

The third FO phase yielded high levels of pacing and hand mouthing (*M*s = 96% and 74%, respectively), a low level of hand flapping (*M* = 6.5%), and no page turning. A third implementation of the R^1 phase eventually suppressed pacing (*M* = 1.63%), yielded decreased but variable levels of hand mouthing (*M* = 19.5%), produced increased levels of page turning (*M* = 36.5%), and generated low levels of both hand flapping and ear covering (*M*s = 3.6% and 3.5%, respectively).

The third panel in Figure 3-1 depicts the percentage of time Mike allocated to hand mouthing across the FO and R^1 phases. Although no intervention was provided for hand mouthing, data from Figure 3-2 suggest that Mike allocated more time to hand mouthing when he was permitted to engage in pacing (i.e., during FO) and that this behavior was substantially decreased when pacing was not permitted. The fourth panel in Figure 3-1 depicts the percentage of time Mike allocated to page turning. Although page turning did not occur during the first two phases, data from this figure suggest that page turning occurred for a greater percentage of time when pacing was restricted than when pacing was available.

Figure 3-2 shows the mean percentage of time Mike allocated to each behavior across the FO and R^1 phases. In terms of time allocated to and order of preference for pacing and hand mouthing, data from Figure 3-4 suggest that Mike's preference for

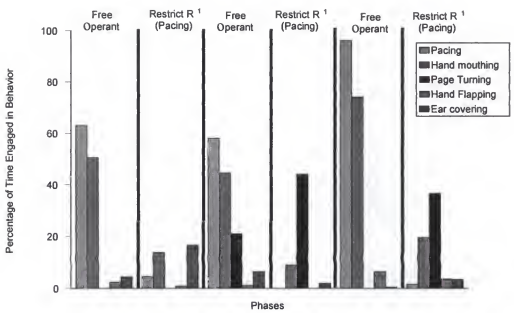


Figure 3-2. Mean percentage of time Mike allocated to stereotypy across phases. stereotypy was consistent across the three FO phases; however, an increase in time allocation to pacing and hand mouthing was noted during the third FO phase. Mike's preference for other forms of stereotypy (as determined by the criteria above) was less clear. Figure 3-2 shows that ear covering was exhibited at low and variable levels across both the FO and R^1 phases and page turning was exhibited during only one FO phase and two R^1 phases. Thus, it is difficult to determine Mike's relative preference for stereotypy beyond the first and second ordered behaviors. Conversely, Figure 3-2 shows that response preference and time allocation were consistent during the last two R^1 phases with the highest percentage of behavior allocated to page turning, followed by comparably lower levels of hand mouthing. In general, the data from Figure 3-2 suggest that Mike spent less time engaged in hand mouthing and more time engaged in page turning when pacing was not available.

Figure 3-3 shows representative within-session (i.e., minute by minute) patterns of pacing and hand mouthing during FO sessions. In session 6 (top panel), Mike did not

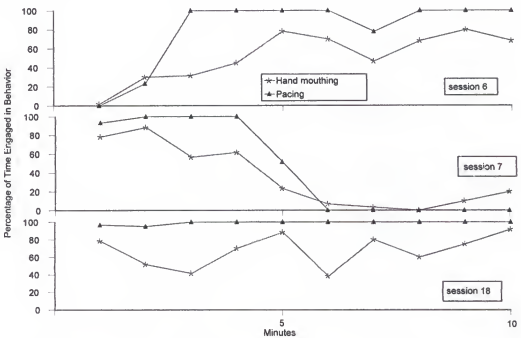


Figure 3-3. Within-session patterns of response allocation to hand mouthing and pacing across minutes during session 6 (top panel), session 7 (middle panel), and session 18 (bottom panel) for Mike.

allocate time to pacing or hand mouthing during the first minute, but he began to allocate time to both behaviors during the second minute (note that the behaviors occurred simultaneously). Allocation to both behaviors remained high throughout the remainder of the session. Session 7 (middle panel) shows the Mike allocated high proportions of time to pacing and hand mouthing during the first four minutes of the session, but, thereafter, allocation to both behaviors reduced to near-zero levels for the remainder of the session. Session 18 (bottom panel) shows a similar pattern of high time allocation to pacing and moderate to high allocation to hand mouthing. Although either behavior could have been exhibited alone, data from Figure 3-3 suggest that Mike tended to engage in these behaviors at the same time.

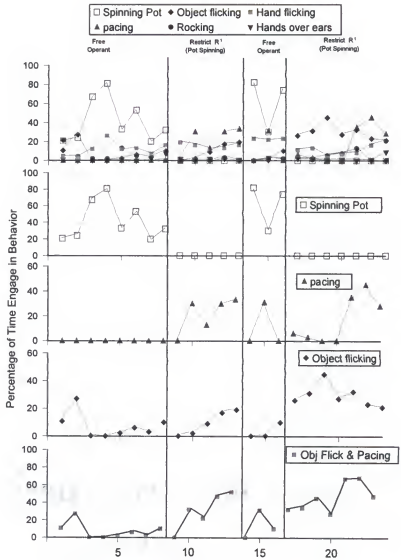


Figure 3-4. Percentage of time Mary allocated to all response forms (first panel), pot-lid spinning (second panel), pacing (third panel), object flicking (fourth panel), and object flicking and pacing (combined; fifth panel) across sessions.

Figure 3-4 shows the percentage of time Mary allocated to pot-lid spinning, object flicking, hand flapping, pacing, body rocking, and ear covering across FO and R^1 phases at her home. Visual analysis of data collected during the first FO phase (see first and second panels) indicated that Mary allocated the highest percentage of time to pot-lid

spinning during 7 of the 8 sessions (it was the second most preferred response in the other session; $M = 41.3\%$). Mary also exhibited low but consistent levels of hand flapping ($M = 11.7\%$) and slightly lower levels of object flicking ($M = 7.33\%$). In the first R^1 phase, during which the pot lid was removed, Mary allocated moderate levels of time to pacing ($M = 26.5\%$), which emerged during session 10, hand flapping ($M = 14.8\%$), and object flicking ($M = 9.4\%$). A return to the FO phase produced high levels of time allocation to pacing ($M = 82\%$), moderate levels of hand flapping ($M = 22.7\%$) and pacing ($M = 10.33\%$; occurred only during session 15), and lower levels of object flicking ($M = 3.4\%$). The second implementation of the R^1 phase produced an immediate increase in object flicking ($M = 29.25\%$) that persisted for four sessions; however, this pattern was displaced by an increase in pacing ($M = 16.6\%$) during sessions 21 through 23. Mary also allocated a moderate, but gradually increasing, amount of time to hand flicking ($M = 11.33\%$).

Figure 3-4 (third panel) shows the percentage of time Mary allocated to pacing across the FO and R^1 phases. Data from this figure show that Mary did not engage in pacing until the second session of the first R^1 phase. A return to the FO phase was marked by the suppression of pacing in the first session, an increase in pacing to a level equivalent to that observed in the first R^1 phase in the second session, and then a return to zero-levels for the third session. The second R^1 phase was marked by near-zero levels of pacing for the first four sessions and then a sharp increase to previously observed levels for the remaining three sessions.

Figure 3-4 (fourth panel) shows the percentage of time Mary allocated to object flicking only across the FO and R^1 phases. During the first FO phase, Mary's time

allocation to object flicking was low and variable. In the following R^1 phase, a slight increasing trend in time allocated to object flicking became evident as this behavior emerged to become the second most preferred response. A return to the FO phase again resulted in relatively low levels of time allocation to object flicking, but a slight increase was noted during the last session of this phase. In the final R^1 phase, Mary's time allocation to object flicking was moderate and relatively stable. Specifically, object flicking appeared to be the most preferred response for the first four sessions of this phase, after which time a gradual, decreasing trend became evident. This decreasing trend was correlated within an increase in time allocation to pacing (see third panel).

Figure 3-4 (fifth panel) shows the percentage of time Mary allocated to pacing and object flicking combined. In general, the data show substantial increases in both behaviors when the pot-lid was restricted and suggest that these two behavior account for most of the time that was made available by restricting the pot-lid.

Figure 3-5 shows the mean percentage of time allocated to the four most preferred responses, which were pot-lid spinning, hand flapping, pacing, and object flicking during the FO and R^1 phases. The means from both FO phases show that when the pot-lid was available (i.e., during FO), Mary's relative time allocation was highest for pot-lid spinning, followed by hand flapping. When the pot-lid was restricted, Mary engaged in higher levels of pacing and object flicking (than during the FO phases) with alternating preference for one of these responses over the other across consecutive sessions (see Figure 3-4). The amount of time Mary allocated to hand flapping did not appear to change as a function of the restriction manipulation in this setting.

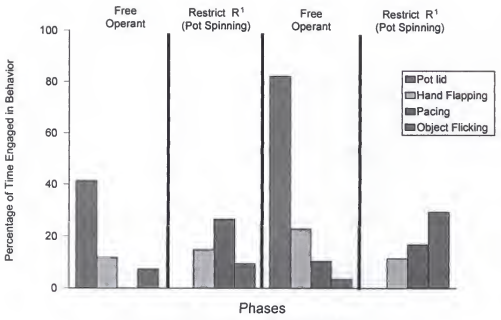


Figure 3-5. Mean percentage of time allocated to stereotypy across phases.

Following the analysis that was conducted at Mary's home, the conditions were repeated in a room at Mary's school. Figure 3-6 depicts Mary's behavior allocation during the FO and R^1 phases that were conducted at her school. Figure 3-6 shows the percentage of time Mary allocated to pot-lid spinning, object flicking, ear covering, mirror viewing (denoted "mirror"), running in circles (denoted "circles"), hand flapping, pacing, object flicking, carpet rubbing (denoted "rubbing"), and finger licking. During the first five sessions of the initial FO phase, Mary allocated variable amounts of time to several different responses. Beginning with session 6, Mary exhibited relatively high levels of pot-lid spinning (M = 40.67%; see second panel), moderate levels of pacing (M = 23%) and hand flapping (M = 22.44%), and low levels of mirror viewing (M = 12.44%)

and object flicking (M = 7.02%). Based on these results (and the criteria for establishing preference described above), the pot-lid was removed during the subsequent restriction

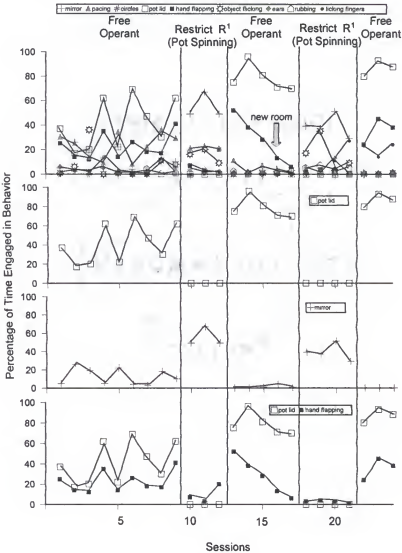


Figure 3-6. Percentage of time Mary allocated to all behavior (first panel), pot-lid spinning (second panel), mirror viewing (third panel), and pot-lid spinning and hand flapping (fourth panel) across sessions at school.

phase. In the first R^1 phase, the percentage of time Mary allocated to the mirror (M = 55%) and object flicking (M = 15%) immediately increased, hand flapping decreased (M = 10%), and pacing remained relatively unchanged (M = 21.6%). The second FO phase produced high levels of pot-lid spinning (M = 78.6%), moderate levels of hand flapping

(M = 27.4%), and near-zero levels of pacing, mirror viewing, and object flicking (Ms = 4.8%, 1.2%, and 1.4%, respectively). Although the mean percentage of time allocated to hand flapping during this phase was relatively high, a decreasing trend across successive sessions was evident.

A return to the R^I phase produced an increase in the percentage of time Mary allocated to mirror viewing (M = 39%) and object flicking (M = 16%), a decrease in time allocated to hand flapping (M = 2.75%), and low levels of pacing (M = 2%). The third session in this phase (i.e., session 20) was marked by the emergence of a novel response form, finger licking, which also occurred at a moderate level in session 21. During the last FO phase, Mary again displayed high levels of pacing and hand flapping (Ms = 87% and 35.67%, respectively), moderate levels of finger licking (M = 19.8%), and near-zero levels of mirror viewing, pacing, and object flicking.

Figure 3-6 (third panel) shows the percentage of time Mary allocated to mirror viewing during the FO and R^I phases that were conducted at her school. During the first FO phase, Mary exhibited variable levels of mirror viewing (range, 3% to 26%), which made it the fourth preferred response, but she allocated almost no time this behavior during the subsequent FO phases. When pot-lid spinning was restricted in the R^I phases, mirror viewing increased substantially and became the most preferred behavior. The arrow in session 16 indicates a change to a different assessment room. Although this room was substantially smaller than the previous one, the change did not appear to be correlated with any difference in time allocation to mirror viewing.

Figure 3-6 shows (fourth panel) the percentage of time Mary allocated to hand flapping during the FO and R^I phases. During the initial baseline, Mary engaged in a

moderate and stable level of hand flapping. Initiation of R^1 was marked by an immediate reduction in hand flapping that included a slight increase in this behavior during session 13. A return to FO produced a return to previously observed levels of hand flapping; however, this behavior steadily decreased across the next four sessions. In the subsequent R^1 phase, Mary exhibited near-zero levels of hand flapping across the four sessions in this phase. In the final FO phase, Mary displayed levels of hand flapping (and pot-lid spinning) that were comparable to that seen in the initial FO phase.

Figure 3-7 shows the mean percentage of time that Mary allocated to pot-lid

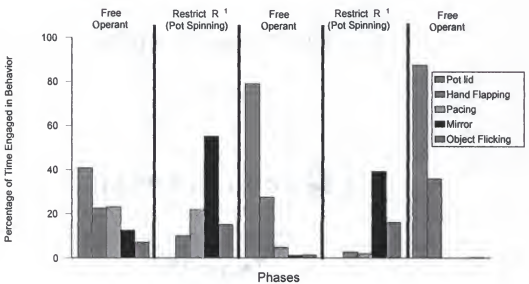


Figure 3-7. Mean percentage of time Mary allocated to stereotypy across phases at her home.

spinning, hand flapping, pacing, mirror viewing, and object flicking during FO and R^1 phases. Data in Figure 3-7 indicate that Mary consistently allocated the most time to pot-lid spinning and hand flapping during the FO phases (see also fourth panel of Figure 3-6); thus, these behaviors appeared to be most and second most preferred, respectively.

Although varying levels of other behavior were also observed during the initial FO phase, these response forms were exhibited at near-zero levels during the two subsequent FO phases. As such, it is difficult to ascertain Mary's relative preference for other responses. Figure 3-7 also indicates that when the pot-lid was restricted, several changes in response allocation occurred. Specifically, hand flapping decreased and both mirror viewing and object flicking increased substantially. These changes were such that, in order of preference, mirror viewing became most preferred and object flicking either second or third.

Figure 3-8 shows representative within-session patterns of pot-lid spinning and hand flapping for Mary during FO sessions at her school. Session 14 (top panel) shows that Mary consistently engaged in high levels of pot-lid spinning, while she engaged in moderate levels of hand flapping. Session 22 (bottom panel) shows a similar pattern of allocation for minutes 1 through 15, but, thereafter, shows that both pot-lid spinning and hand flapping become quite variable. Decreases in both behaviors are noted during the same minutes and neither behavior was exhibited during minutes 23 and 24. Nevertheless, both behaviors returned to previously observed levels for the remainder of the session. In general, decreases in pot-lid spinning within a given minute were correlated with decreases in hand flapping.

Figures 3-9 shows the percentage of time Geff allocated to various topographies of stereotypy. Due to the large number of responses emitted by Geff and the variability in many of the responses across successive sessions, data representing these behaviors have been separated into multiple figures. Specifically, the most preferred responses have been isolated in the top two panels of Figure 3-9. Figure 3-9 (first panel) shows that during the

first FO phase, Geff allocated variable amounts of time to both snorting ($M = 61.04\%$) and hand rubbing ($M = 60.54\%$). Figure 3-9 (third panel) shows the mean percentage of

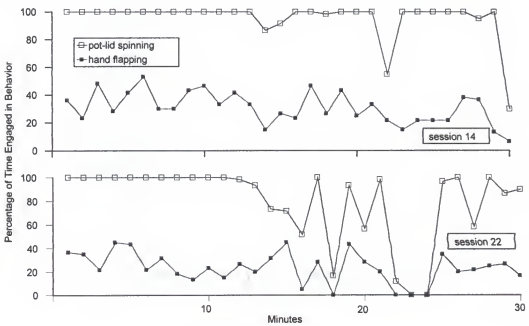


Figure 3-8. Within-session response allocation to pot-lid spinning and hand flapping across minutes during session 14 (top panel) and session 22 (bottom panel).

time for the four behaviors to which Geff allocated the most time during the first FO phase (this allocation remained consistent during the subsequent FO phases). The fourth panel depicts the percentage of time Geff allocated to less preferred forms of stereotypy (and self-injurious behavior).

Despite the variability that was observed in Figure 3-9 (first panel) during the first FO phase, data show (first and third panels) that Geff allocated the highest proportion of time to snorting and hand rubbing, with moderate to low levels of time allocation to body rocking (second panel; $M = 31.32\%$) and hand flicking ($M = 9.27\%$). Because Geff

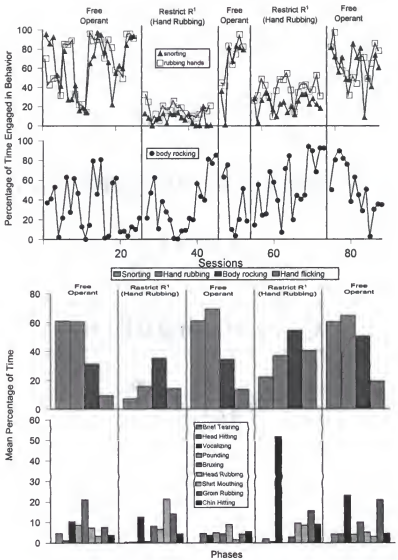


Figure 3-9. Percentage of time Geff allocated to snorting and hand rubbing (first panel), body rocking (second panel), the four most preferred response forms (third panel), and other behavior (fourth panel).

allocated comparable amounts of time to snorting and hand rubbing, we opted to restrict access to hand rubbing using response blocking. The choice to restrict hand rubbing enabled the therapist to use a less invasive intervention then that which would have likely

been required to restrict access to snorting. Thus, in the R^1 phase, hand rubbing was restricted using a fixed-ratio 1 (FR 1) schedule of blocking.

In the first R^1 phase, the time Geff spent hand rubbing (M = 15.71%) and snorting (M = 7.12%) decreased substantially, while time allocated to body rocking (M = 35.2) and hand flicking (M = 14.21%) increased slightly. A return to the FO phase produced a slow but steady increase in time allocation to both hand rubbing (M = 69.3%) and snorting (M = 61.1%) and little change in levels of body rocking (M = 34.5%) or hand flicking (M = 13.5%). The second implementation of R^1 again decreased hand rubbing and snorting (Ms = 37% and 22.1%, respectively) and substantially increased time allocation to body rocking (M = 54.38%) and hand flicking (M = 40.32%). A third return to FO resulted in high levels of hand rubbing and snorting (Ms = 64.62% and 60.37%, respectively), a comparable level of body rocking (M = 50.43%), and a reduction in hand flicking (M = 19.17%).

Figure 3-9 (top panel) shows the percentage of time Geff allocated to snorting and hand rubbing across the FO and R^1 sessions. With respect to snorting, levels were variable during the initial FO phase (range, 11% to 95%) and became low and stable during the first R^1 phase. A return to FO was marked by an increase to high and stable levels of snorting. Implementation of the second R^1 phase again reduced snorting, but to a lesser extent than in the first R^1 phase. A third return to FO yielded moderate to high levels of snorting. Thus, as indicated in the first and third panels of Figure 3-9, snorting appeared to be among the most preferred responses for Geff when hand rubbing was available. By contrast, when hand rubbing was restricted via response blocking and, thereby reduced, time allocated to snorting was proportionally reduced. In short, although

no intervention was provided for snorting, time allocation to this behavior decreased when hand rubbing was restricted and increased when hand rubbing was permitted.

Figure 3-9 (panel two) depicts the percentage of time Geff allocated to body rocking across the four phases. Although phase-means indicated that levels of body rocking were relative stable across the FO and R^1 phases (see panel 3), panel 2 of Figure 3-9 shows that body rocking gradually increased when hand rubbing was restricted and decreased when hand rubbing was again available. This response patterns suggest that the availability of hand rubbing altered Geff's preference for body rocking.

Figure 3-10 shows representative within-session patterns for Geff's hand rubbing and snorting during FO sessions. Although data for Geff were presented in 10-min sessions in the previous figure, the two panels in Figure 3-10 display data from days during which 3 consecutive 10-minute sessions were conducted (recall that 1 to 3 sessions were conducted daily). Data from sessions 3, 4, and 5 (top panel) show a decreasing trend for both hand rubbing and snorting during the first 10 minutes (session 3), an increasing trend for both behaviors during the second 10 minutes (session 4), and relatively high stable levels of both behaviors during the last 10 minutes (session 5). Data from sessions 9, 10, and 11 (bottom panel) show that Geff allocated relatively low but stable levels of time to both hand rubbing and snorting across all three 10-minutes sessions. In general, data from this figure show that hand rubbing and snorting tended to covary within and across sessions.

Figure 3-11 depicts the percentage of time Alice engaged in pacing, vocalizations, clothing manipulation, and carpet rubbing. Unlike the prior participants, the present experiment was not the first in which Alice participated (her response allocation was

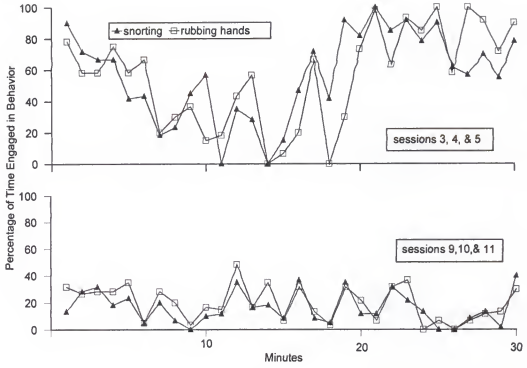


Figure 3-10. Within-session response allocation to hand rubbing and snorting across minutes.

first assessed during the study described in Chapter 4). Therefore, the data depicted in Figure 3-11begin in R^1 (B-A-B-A, as opposed to A-B-A-B), where access to pacing was restricted in the same manner as described for Mike (i.e., use of an inhibitory stimulus control procedure) and was followed by the FO phase. In the first R^1 phase, Alice allocated a moderate to high percentage of time to vocalizations (M = 54.9%) and low to moderate amounts of time to clothing manipulation (M = 25.3 %). The first FO phase resulted in high response allocation to pacing (M = 68.52%), relatively unchanged allocation to vocalizations (M =52.55%), and low levels of allocation to clothing manipulation and carpet rubbing (Ms = 10.11% and 9.3%, respectively). The second R^1 phase produced high, yet slightly lower, levels of vocalizations (M = 63.7%) and low levels of clothing manipulation (M = 11.34%) and carpet rubbing (M = 0.5%). A return to

FO produced high response allocation to pacing (M = 87.72%), moderate allocation to vocalizations (M = 47.94%), and low allocation to carpet rubbing and clothing manipulation (Ms = 5% and 2.89%, respectively).

Figure 3-11 (middle panel) shows the percentage of time Alice allocated to vocalizations during the R^1 and FO phases. In general, the data show only minor variability in the amount of time Alice allocated to vocalization across sessions when pacing was restricted and available. In short, although vocalization became the most preferred response when pacing was restricted, Alice's preference (as indicated by time allocation) for vocalizations did not appear to be influenced by the availability of pacing (i.e., time allocation was stable across conditions).

Figure 3-11 (bottom panel) shows the phase-means for pacing, vocalizations, carpet rubbing, and clothing manipulation. This panel shows that during FO, Alice allocated the most time to pacing and then to vocalizations; thereby representing the most and second-most preferred responses, respectively. This figure also shows that vocalizations became the most preferred response during R^1; however, the level of vocalizations did not change as a function of the pacing restriction. No consistent changes in response allocation to carpet rubbing or clothing manipulations are apparent from this data.

Tables 3-1, 3-2, and 3-3 show the results of the correlational and conditional probabilities analyses for Mike, Geff, and Alice, respectively. For Mike, Table 3-1 shows that pacing was significantly correlated with four other stereotyped behaviors. Moderately strong correlations between pacing and hand flapping and pacing and hand mouthing were found for the FO phase. Secondary analyses show that the conditional probability of hand mouthing (given the occurrence of pacing) was higher than the

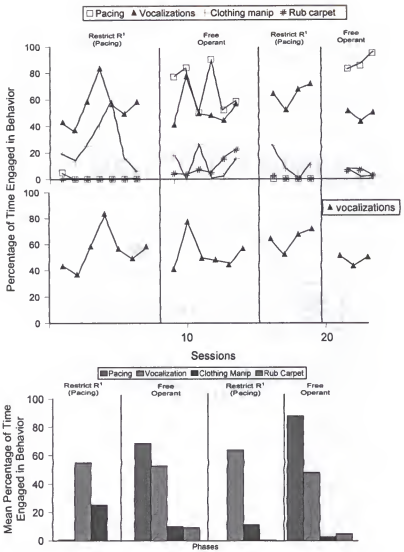


Figure 3-11. Percentage of time Alice allocated to all response forms (top panel) and vocalizations (middle panel), and the mean percentage of time allocated to stereotypy across phases (bottom panel).

unconditional probability, which indicates that hand mouthing was more probable when Mike was engaged in pacing than when he was not. Although a significant correlation was not detected for hand mouthing and pacing during the R^1 phase, the conditional probability of hand mouthing was considerably higher than the unconditional probability.

Conversely, the conditional probability of hand flapping (given the occurrence of pacing) was lower than the unconditional probability, indicating that Mike allocated more time to

Table 3-1. Analyses of Mike's stereotyped behaviors

	Free Operant			Restrict R^1		
Behaviors	r_s	Conditional[a]	Unconditonal[a]	r_s	Conditional[b]	Unconditional[b]
Hand flapping/ Pacing	.676*	.049	.063	.113	.048	.029
Hand bite/ Pacing	.571*	.006	.009	-.762**	.001	.0144
Hand mouthing/ pacing	.770*	.534	.3542	.389	.293	.089
Hand bite/ Hand mouthing	.047	.009	.009	.675**	.072	.0144
Ear covering/ Pacing	-.723*	.0683	.0419	.304	.0784	.0835
Ear covering/ Hand mouthing	-.648*	.0102	.0419	-.018	.078	.0835
Hand biting/ Hand flapping	.175	.028	.009	.707**	.168	.0144
Ear covering/ Pacing	.310	0	.0419	-.762**	.0102	.0835

[a]n = 13. [b]n = 15.
*p< .05. ** p< .01.

hand flapping when he was not pacing. During R^1, the relationship between these behaviors became insignificant and the conditional probability, which was relatively unchanged from the FO phase, became higher than the unconditional probability. Table 3-1 also shows a positive correlation between hand biting and pacing during the FO phase; however, conditional probabilities analyses indicates that hand biting tended to be a low probability behavior in both the presence and absence of pacing. During the R^1

phase, a significant, negative correlation was revealed for hand biting and pacing. In addition, the conditional probability of hand biting was lower than the unconditional probability, indicating that Mike engaged in more hand biting when he was not pacing. Moderately strong, negative correlations were also found for ear covering and pacing, and ear covering and hand mouthing during the FO phase. By contrast, neither pair of behaviors was significantly correlated during the R^1 phase. For both behavior-pairs, the conditional probability was lower than the unconditional probability in the FO and R^1 phases, indicating that ear covering was less probable when Mike was pacing or when he was hand mouthing.

Table 3-2 shows the results for Geff's stereotyped behaviors. For the FO and R^1 phases, analyses yielded a significant, moderately strong correlation for snorting and hand rubbing, and a higher conditional probability than unconditional probability, which indicates that snorting was more probable when Geff was hand rubbing. In addition, significant, moderate negative correlations were revealed for hand flapping and hand rubbing, and vocalizations and hand rubbing, which were accompanied by higher conditional than unconditional probabilities, during the FO phase. Thus, hand flapping and vocalizing were less probable when Geff was hand rubbing. Conversely, these

Table 3-2. Analyses of Geff's stereotyped behaviors

	Free Operant			Restrict R^1		
Behaviors	r_s	Conditional[a]	Unconditonal[a]	r_s	Conditional[b]	Unconditional[b]
Snorting/ Hand rubbing	.590**	.790	.5523	.692**	.317	.095
Hand flapping/ Hand rubbing	-.562**	.2280	.1224	.547**	.1668	.1372

Vocaliz-ations/ Hand rubbing	-.462**	.3677	.0967	.663**	.2965	.152
Hand Flapping/ Vocaliz-ations	.301	.1814	.1224	.764**	.347	.1372

[a]n = 32. [b]n = 38.
** p< .01.

relationships became positive during the R^1 phase, but the conditional probabilities were again higher than the unconditional probabilities. A significant positive correlation was also noted for hand flapping and vocalizations during the R^1 phase, for which a higher conditional than unconditional was shown (i.e., hand flapping was more probable when Geff was engaged in vocalizations).

Table 3-3 shows the results for Alice's stereotyped behaviors. During the FO phase, statistical analyses yielded moderately strong significant, negative correlations for

Table 3-3. Analyses of Alice's stereotyped behaviors

	Free Operant			Restrict R^1		
Behaviors	r_s	Conditional[a]	Unconditonal[a]	r_s	Conditional[b]	Unconditional[b]
Clothing manipulation/ Pacing	-.612**	.211	.2956	.100	.000	.089
Carpet rubbing/ Pacing	-.766*	.00026	.087	-.100	.000	.0021

[a]n = 22. [b]n = 11.
*p< .05. ** p< .01.

clothing manipulation and pacing, and carpet rubbing and pacing with lower conditional than unconditional probabilities for both behavior-pairs. Thus, Alice allocated more time to both clothing manipulation and carpet rubbing when she was not pacing. By contrast, neither behavior-pair produced a significant correlation during the R^1 phase.

Discussion

Results from the present study showed that each participant exhibited a relative preference for a specific topography of stereotypy (i.e., the stimulation derived from thereferent behavior) under free operant conditions. In addition, three general patterns of response reallocation emerged when the response that was identified as most preferred was restricted. In the first pattern, restriction of the most preferred response yielded reductions in an untargeted response (e.g., restriction of Mike's pacing also decreased hand mouthing); the significance of this pattern was supported by statistical and conditional probabilities analyses. In the second pattern, restriction of the most preferred response produced a consistent increase in a previously less preferred response (e.g., restriction of Mary's pot-lid spinning increased her time allocation to the mirror). In the third pattern, restriction of the most preferred response did not alter time allocation to other response forms (e.g., restriction of Alice's pacing did not produce consistent change in any other behavior). These patterns were also displayed in various combinations. For example, when Mike's hand mouthing decreased during restriction of pacing, page turning emerged as the most preferred response.

Hierarchies of preference were also evident for some participants as was reflected by relatively consistent time allocation to the same behaviors across repeated sessions and phases. Similarly, during the restriction phase, Mike, Mary, and Geff (to a lesser extent) showed consistent time reallocation to behavior that was not highly preferred during FO. Consistent preference for different behaviors based on available operants provides some support for hierarchies of stereotypy (Rollings & Baumeister, 1982; Rollings et al., 1977).

The reduction in untargeted responses that were exhibited during restriction of the most preferred response was consistent with previous treatment studies involving automatically reinforced behavior (e.g., Friman & Hove, 1987; Johnson et al., 1982). Mike and Mary (in both the home and school settings) also displayed the highest levels of their most preferred response (during a single session) following the restriction of the respective response. The subsequent increase in time allocation suggests that the restriction condition may have imposed deprivation (i.e., increased the establishing operation) for the reinforcement produced by the stereotyped response (see Klatt & Morris, 2001). This outcome is similar to that of prior studies, which reported increases in time allocated to a behavior or an activity following a period of restriction (Bernstein & Ebbesen, 1978; Forehand & Baumeister, 1971; 1973; McIntee & Saunders, 1997; Patel et al., in press).

Interestingly, as a probable byproduct of increased time allocation to the most preferred response, the imposition of restriction may have decreased time allocation to less preferred responses. For example, data for both Mike and Mary show that neither allocated any time to the response (i.e., page turning and mirror-viewing, respectively) that was most preferred during R^1 during the subsequent FO phase, even though the response was exhibited during the initial FO phase. In short, deprivation for the reinforcement produced by the most preferred stereotypy may have overridden the reinforcing effects generated by less preferred behaviors. Although this explication is merely speculative, the possibility could have been further evaluated by conducting additional sessions within the respective FO phases to determine if responding would have reallocated after extended access to the previously withheld response.

Alice did not exhibit consistent reallocation to another form stereotypy under conditions of R^1 restriction, nor did she display increases in her most preferred response following its restriction. Interestingly, both Alice and Geff required therapist mediated interventions to restrict their most preferred behavior and both individuals engaged in high levels of aggressions toward the therapist during sessions where blocking was imposed. Thus, aggressive responses (e.g., kicking the therapist) may have displaced or consumed time that may have been allocated to other stereotypy for Alice.

The changes in response allocation exhibited by Mike, Mary, and Geff during R^1 were particularly interesting because only one other form of stereotypy decreased, which suggests that treatment of the most preferred stereotypy was not merely correlated with a general reduction in stereotyped behavior (e.g., generalized suppression via punishment effects). Moreover, the fact that this pattern was replicated within and between subjects warrants some discussion. At least three operant interpretations are, on some level, tenable. In the clinical literature, Friman and Hove (1987) found that repetitive hair pulling of several children was eliminated when thumb sucking was suppressed with contingent punishment; however, Friman and Hove also noted that thumb sucking preceded nearly every instance of hair pulling. In basic research with nonhumans, Dunham and Grantmyre (1982) described this behavior-behavior relationship in terms of "sequential dependency." Such a pattern suggests that the two behaviors occurred in a response chain wherein a disruption or decrease in the first behavior precludes the occurrence of the latter. The present data do not necessarily conform to the patterns described in either study. In fact, for each participant, the response that was shown to decrease during R^1 was also shown to occur, though infrequently, independent of the

most preferred response (e.g., Mike displayed hand mouthing when pacing was unavailable). Therefore, reductions in untargeted responses that occurred during R^1 are not readily explained in the context of interrupting a response chain.

It is also possible that engagement in the "covaried" response (i.e., the untargeted behavior that decreased when was R^1 restricted) was a function of its compatibility with the most preferred response (i.e., engagement in R^1 narrowed the range of behaviors that could be simultaneously displayed). For example, Mike might have engaged in hand mouthing when he was pacing (his most preferred response) because it was the only other response that produced an automatic consequence, which he could emit while pacing (i.e., hand mouthing was available). In keeping with this position, engagement in pacing necessarily reduced the number of concurrently available alternative responses (e.g., Mike could not body rock while he was pacing). When pacing was unavailable, Mike allocated time to behavior that was available when he was seated (Mike was required to sit during R^1). Even though hand mouthing was still available while Mike was seated, he presumably chose to engage in page turning because it produced more potent reinforcement (and he could not turn pages and hand mouth at the same time). Thus, using the above explanation, the behavior-behavior relationships observed in this study could have been an indirect product of changes in concurrently available operants.

Given the apparent sequential independence of the covaried responses (i.e., they did not appear to be part of a chain) exhibited by the current participants, the close temporal proximity of these behaviors suggests that the products may be described as complementary reinforcers (see Green & Freed, 1993). That is, the products of the two responses (or commodities) may have been more potent reinforcers when both were

produced simultaneously than when either was produced alone. Although the data patterns suggest that the response forms in question were often exhibited simultaneously, the relationship remains equivocal because bilateral complementarity was not evaluated in the present study. To make a more definitive conclusion about this reinforcer-reinforcer relationship, it would have been necessary to show reductions in R^1 when R^x (i.e., the behavior that covaried with R^1) was withheld (i.e., bilateral complementarity); this manipulation was beyond the scope of the current analysis.

It is possible that covaried reductions in hand mouthing and snorting during R^1 for Mike and Geff, respectively, were the result of punishment (adventitious) that was provided contingent on R^1 (R^2 and R^1often occurred in close temporal proximity; see Lerman, Kelley, Vorndan, & Van Camp, in press). Nevertheless, this explanation seems untenable because the same procedure that was used for Mike did not reduce R^2 for Alice (vocalizations persisted at a relatively stable level across conditions). Likewise, simple prevention of R^1 (i.e., the item used for stereotypy was unavailable) reduced R^2 for Mary. Consistent with this position, Dunham and Grantmyre (1982) found that nonhuman subjects exhibited comparable reductions in the same untargeted behaviors when R^1 was either punished or made unavailable. Thus, it is unlikely that the selected method for reducing the most preferred response directly influenced changes in untargeted behaviors.

The results of the conditional probabilities analyses showed significant relationships between Mike's and Geff's most preferred stereotyped behavior and the untargeted stereotyped behavior that decreased during the restriction phase. For Mike and Geff, this relationship was evident in both the FO and R^1 phases. Supplemental analyses using conditional probabilities also showed that the covarying behavior (hand mouthing and

snorting for Mike and Geff, respectively) was more probable when the most preferred response was already occurring. Thus, these results provide support for the position that Mike and Geff exhibited stereotyped behaviors that may have produced complementary reinforcement. No significant positive relationships were noted for Alice's behaviors.

It is interesting to note that a strong, positive correlation did not necessarily indicate that two behaviors occurred simultaneously. Rather, in addition to a positive correlation, an elevation in the conditional probability, in comparison to the unconditional probability, provided the requisite support for the simultaneously exhibition of two behaviors. In fact, a positive correlation did not necessarily indicate that the two behaviors occurred at close points in time. For Mike, both hand flapping and hand biting were positively correlated with pacing; however, the unconditional probability was higher for both behaviors (i.e., hand flapping and hand biting were more exhibited more often when Mike was not engaged in pacing). Thus, proper interpretation of these behavior relationships required multiple analyses.

Although the intended purpose of these analyses was to explore relationships between behaviors with complementary response products, the emergence of negative correlations for stereotyped behaviors, which were exhibited by all three participants, was also a significant clinical and conceptual finding. From the present data, it appears that a negative correlation between two behavioral events was described by a higher unconditional than conditional probability. For Geff, it is also interesting note that two significant correlations that were negative during the FO phase became positive during the R^1 phase. For Mike, the converse was noted for one behavior pair. It is not clear why these relationships changed during the restriction phase. Nevertheless, data from

experiment 1 suggest that these changes for Geff and Mike are the product of different processes. For Geff, hand rubbing was initially high during FO whereas hand flapping and vocalizations were both low; thus the latter two behaviors were inversely correlated with hand rubbing. When hand rubbing was substantially reduced to lower levels during R^1, it was then correlated with low levels of both hand flapping and vocalization, both of which increased during this phase. For Mike, hand biting and pacing were positively correlated during FO, but became inversely correlated during R^1. Pacing was Mike's most preferred response during FO and was subjected to intervention in the restriction phase, which resulted in pacing suppression. At the same time that pacing decreased, time allocated to hand biting increased during periods when pacing was absent.

In summary, the current results provide a method for assessment of response hierarchies for individuals with multiple stereotyped response forms. In addition, the present data suggest that the results of statistical and conditional probabilities analyses may provide additional tools to help evaluate stereotyped behaviors at both a molecular and a molar level. The next experiment will evaluate the extent to which response reallocation (away from stereotypy) can be facilitated during conditions of an enriched environment.

CHAPTER 4
ENVIRONMENTAL ENRICHMENT

Broadly defined, studies involving environmental enrichment (EE) as treatment for stereotypy have typically involved the provision of stimuli that are intended to indirectly reduce stereotypy by providing competing sources of reinforcement (e.g., Davenport & Berkson, 1963; Mason & Newsom, 1990; Patel, Carr, Kim, Robles, & Eastridge, 2000; Vollmer, Marcus, & LeBlanc, 1994; Wilder, Kellum, & Carr, 1999). In a series of pioneering studies on EE, Berkson and colleagues evaluated the effects of various environmental events on stereotyped behaviors of institutionalized individuals with disabilities (Berkson, 1964; Berkson & Mason, 1963, 1964; Davenport & Berkson, 1963). Davenport and Berkson (1963) conducted initial observations of individuals' stereotyped behavior in their natural living environment and then re-evaluated their behavior following the addition of specific stimuli (e.g., blocks, ball). Using statistical analyses of aggregated group data, the authors found that stereotypy was significantly lower in each condition where an object was present than in conditions where objects were absent. Thus, Davenport and Berkson were among the first researchers to demonstrate that environmental variables could influence the amount of time institutionalized individuals with DD engaged in stereotypy.

In an extension of the early research by Berkson and colleagues, Horner (1980) analyzed specific stimulus features of EE, such as the availability of manipulable objects (from which stimulation could be derived) and social reinforcement (e.g., adult interaction). In part, Horner's results showed clear reductions in participants' repetitive

behavior (e.g., rectal digging, self-scratching) and increases in "adaptive behavior" (i.e., object manipulation) during periods when the environment was enriched.

Although stereotypy was substantially reduced in the Horner (1980) study, it is unclear what operant mechanism was responsible for the behavior reductions; at least three interpretations can be offered to account for Horner's effects. First, object manipulation may produce stimulation that is similar to that of stereotypy (e.g., both stereotypy and object manipulation produce tactile stimulation). Second, object manipulation may produce stimulation that is dissimilar to, but more efficacious or valuable than, that produced by stereotypy (perhaps due to limited access). Third, as indicated by Horner, object manipulation may become discriminative for delivery of social reinforcement.

Since the early studies by Davneport and Berkson (1963) and Horner (1980), a considerable amount of research has accumulated concerning the effects of EE on problem behavior. Some studies have shown that the availability of alternative sources of stimulation decreased repetitive SIB and increased object interactions without providing social consequences (e.g., Shore, Iwata, DeLeon, Kahng, & Smith, 1997; Ringdahl et al., 1997). Other investigations have reported the need for therapist-guided prompts (antecedent stimuli) to facilitate appropriate interaction with items (e.g., Singh & Millichamp, 1987). Still other studies have shown that environmental enrichment alone does not produce appreciable increases in alternative behavior without first restricting access to stereotypy (e.g., Lindberg, Iwata, & Kahng, 1999). Furthermore, various methods have been developed for identifying the stimuli used during EE (e.g., Patel et al., 2000; Piazza, Adelinis, Hanley, Goh, & Delia, 1998; Vollmer et al., 1994).

The purpose of the present experiment was to further evaluate changes in individuals' stereotypy as a function of environmental enrichment. Experiment 1 showed that treating specific topographies of stereotypy can produce increases in other forms of stereotypy. Given this outcome, the present experiment focused on the extent to which environmental enrichment might produce reductions in multiple forms of stereotyped behavior. The effects of systematically providing stimulation similar to that produced by stereotypy were also analyzed for one participant. Using this approach, the extent to which the availability of a single stimulus produced specific (i.e., one form of stereotyped behavior) or general reductions in stereotyped behavior could be evaluated. If time allocation to only one form of stereotyped behavior decreases in the presence of a specific stimulus and no other behavior (aside from time allocation to the stimulus) changes, the effects of EE for providing substitutable or competing sources of reinforcement can be examined.

Method

Participants

Geff, Alice, and Greg each participated in this study. The settings, target behavior, and data collection were the same as previously described in experiment 1.

Procedures and Design

The effects of the EE manipulations for each participant were evaluated using an ABAB reversal design. The A condition served as the baseline and was identical to the free operant condition described in experiment 1. The B condition served as the experimental condition and involved the addition of competing sources of stimulation (i.e., environmental enrichment; see below). For Geff and Alice, the experimental condition involved a range of stimuli. For Greg, two experimental conditions were used wherein only one of two items was available per condition. Subsequently, a third

condition involved simultaneous access to both stimuli. The purpose of providing only one item at time to Greg was to determine whether the enriching-stimulus produced selective (i.e., the behavior to which the stimulus was matched) or general reductions in stereotyped behavior.

The participants' target stereotypy was assessed using the methods described in Chapter 2. The percentage of time each participant allocated to alternative stimuli during the experimental conditions was also recorded. Object manipulation was defined as any contact with the participant's fingers with the object (it was possible for two objects to be manipulated simultaneously, but this rarely occurred). A second observer scored 30% of the sessions. IOA was calculated in the same manner as described in Chapter 3. IOA scores for each participant's stereotyped behaviors are depicted in Table 2-2. IOA for object manipulation was at least 85% for each participant. Preference for a form of stereotypy was determined based on the same criteria described in Chapter 2. Due to the time-limited nature of Alice's and Greg's participation in these studies, the rules for making phase changes were modified to accommodate brief reversals.

During the *Free Operant (FO)* condition (i.e., baseline), each participant was escorted to the respective setting (see Chapter 2), which was devoid of any stimuli that were not related to the respective individuals' stereotypy. No social consequences were provided during this condition. This condition served as the baseline with which the conditions described below could be compared.

During the *FO plus Enriched Environment (FO+EE)* condition for Geff and Alice, several objects, which potentially produced auditory, visual, and/or tactile stimulation, were made accessible. The objects used in the EE conditions for Alice and Geff were

selected based on reports provided by caregivers. For Alice, EE included a toy phone, a musical keyboard, several books (some played brief songs), a comb, and a bead-shaker. For Geff, EE included large and small attachable blocks, a soccer ball, three large trucks, a musical keyboard, small figurines, and a magna doodle ®.

Three different FO+EE conditions involving two stimuli were conducted with Greg. The stimuli used in these conditions were identified via stimulus preference assessment (e.g., Roane et al., 1998). In the *FO+EE Manga Doodle* condition, a magna doodle was continuously available throughout each session. The purpose of this condition was to evaluate the extent to which stereotyped behavior, such as mirror viewing, may be reduced in the presence of a stimulus that provides alternative visual stimulation. In the *FO+EE Music* condition, a small stereo was present from which music (at approximately 80 to 82dB) that was previously identified as preferred was played continuously during each session. The purpose of this condition was to determine whether stereotyped behaviors that generated audible products (e.g., repetitive vocalizations, screaming) would decrease when ambient music was available. Last, in the *FO+EE magna doodle and music (FO+EE MDM)* condition, both the magna doodle and music were present. Because each stimulus appeared to have a selective effect on Greg's stereotyped behaviors, the purpose of this condition was to determine whether the behavior changes produced with each stimulus alone would maintain, or possibly produce a synergistic effect, when both stimuli were present.

Results

Figures 4-1 (top panel) shows the percentage of time that Geff allocated to stereotyped behavior during FO and FO+EE phases. The top panel of this figure shows that during

the first FO phase, Geff allocated a high percentage of time to snorting (M = 63.2%) and

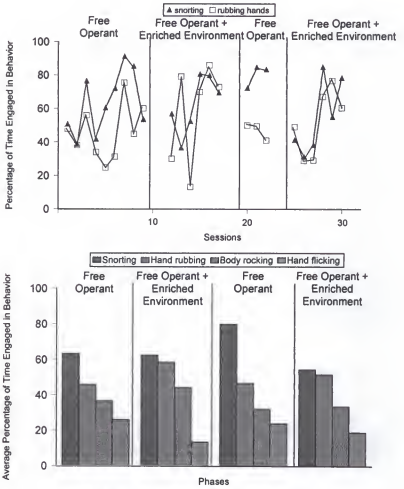


Figure 4-1. Percentage of time Geff allocated to hand rubbing and snorting (top panel) and average percentage of time allocated to hand rubbing, snorting, body rocking, and hand flicking (bottom panel) during FO and FO+EE phases.

hand rubbing (M = 45.67%). In the ensuing FO+EE phase, time allocation to both snorting (M = 62.4%) and hand rubbing (M = 58.44%) was relatively unchanged. The second FO phase resulted in increased time allocation to snorting (M = 79.9%) and comparable levels of hand rubbing (M = 46.66%). The second implementation of the

FO+EE phase was marked by a slight decrease in time allocation to snorting (M = 54.6%) and relatively unchanged levels of hand rubbing (M = 51.75%).

Figure 4-1 (second panel) shows the mean percentage of time that Geff allocated to snorting, hand rubbing, body rocking, and hand flicking. During the first FO phase, Geff allocated the most time to snorting followed by hand rubbing, body rocking, and hand flicking. In the first FO+EE phase, snorting and hand rubbing continued to be Geff's most preferred stereotypies, followed by body rocking and hand flicking. The second FO phase was marked by increased levels of snorting, and unchanged levels and ordering of hand rubbing, body rocking, and hand flicking. The final FO+EE phase resulted in a slight decrease in snorting, but the same pattern of allocation and ordering for the other behaviors. Note that data on object manipulation were not presented because Geff allocated almost no time to the "enriching-stimuli" during FO+EE.

Figure 4-2 (first panel) shows the percentage of time Alice allocated to stereotyped and appropriate behavior during the FO+EE and FO phases. The first panel of this figure shows that Alice's behavior was first evaluated in the FO+EE phase. During the first FO+EE phase, Alice allocated variable amounts of time to pacing (M = 43.16%) and vocalizations (M = 36%), consistently lower but moderate levels of time to clothing manipulation (M = 16.9), low to near-zero levels of time to carpet rubbing (M = 2%), and variable levels of time to the manipulation of enriching-stimuli (total object manipulation; M = 39.77%).

In the first FO phase, pacing was variable for the first two sessions; however, pacing (M = 69.3%) increased substantially in the third session and remained high throughout the phase. Vocalizations (M = 38%) was initially high and variable for the first two

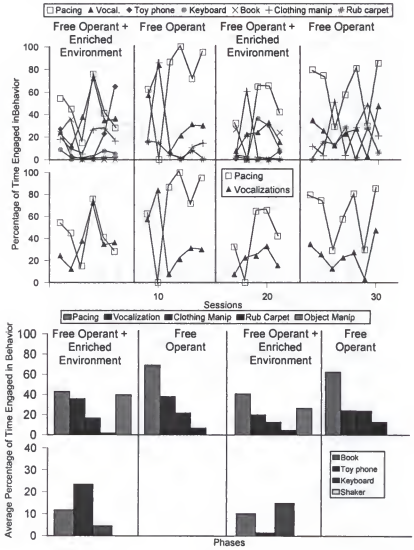


Figure 4-2. Percentage of time Alice allocated to all stereotyped response forms (first panel) and pacing and vocalizations (second panel) during FO+EE and FO phases. Average time allocated to all response forms (third panel) and alternative stimuli during FO+EE and FO phases (fourth panel).

sessions, but decreased to moderate levels for the remaining four sessions. Clothing manipulation ($M = 21.85\%$) was highly variable for the first two sessions and but decreased to lower levels for the rest of the phase. Carpet rubbing ($M = 7.11$) increased

substantially for the first two sessions, but eventually decreased to zero during the last session of this phase. The second FO+EE phase was marked by decreases in pacing (M = 40.9%) for the first two sessions and then an increase to moderate but variable levels of this behavior during the last three sessions. Vocalizations remained moderate and variable across the five sessions, while time allocation to both clothing manipulation (M = 12.95) and carpet rubbing (M = 4.7%) decreased substantially. Alice's time allocation to object manipulation (total; M = 26.49%) was moderate for the first two sessions, near zero for the third and fourth sessions, and then increased to a moderate level for the final session of this phase. In the final FO phase, time allocation to pacing (M = 62.34%) was typically high with some variability (lower in third and sixth sessions of the phase), time allocation to vocalizations was relatively stable (M = 24.32%), and time allocation to both clothing manipulation (M = 23.81%) and carpet rubbing (M = 12.92%) increased and became variable.

Figure 4-2 (second panel) shows the percentage of time Alice allocated to pacing and vocalizations across the FO+EE and FO phases. In general, the second panel shows that Alice allocated a considerable proportion of her time to pacing across both the FO+EE and FO phases; however, in any given session, the percentage of time she allocated to pacing tended to be lower during the FO+EE phases. Specifically, time allocation to pacing never exceeded 80% during a given session within the FO+EE phases. By contrast, Alice's time allocation to pacing during the FO phases approached or exceeded 80% in at least six sessions. Alice's time allocation to vocalizations was variable during the first 14 sessions, but was generally moderate and stable across both the FO+EE and FO phases.

Figure 4-2 (third panel) shows the overall phase means for Alice's stereotyped and appropriate behaviors across the FO+EE and FO phases. The third panel shows that Alice consistently allocated the most and second most time to pacing and vocalizations, respectively, during both phases. Thus, pacing and vocalizations were the most preferred responses even when enriching-stimuli were present. However, Alice's time allocation to pacing was clearly lower in FO +EE than during the FO condition. Likewise, time allocated to both carpet rubbing and clothing manipulation was higher during FO than during FO+EE. Alice's time allocation to vocalization was relatively unchanged across the two phases. The third panel also shows that the percentage of time Alice allocated to object manipulation was substantially lower during the second FO+EE phase than in the first. Figure 4-2 (fourth panel), which shows the overall phase means for Alice's time allocation to each object, indicates that time allocation to the book was relatively consistent, time allocation to the toy phone decreased from the first to the second FO+EE phase, and time allocation to the keyboard increased from the first to the second phase.

Figure 4-3 (top panel) depicts the percentage of time that Greg allocated to stereotyped behavior during FO and FO+EE Magna Doodle phases. During the first FO phase, Greg allocated a relatively high proportion of his time to vocalizations (M = 59.55%) and mirror viewing (M = 42.8%), and considerably lower proportions to pounding (M = 12.6%), yelling (M = 12.51%), thumb sucking (M = 6.5%), and running (M = 5.92%). Implementation of the first FO+EE Magna Doodle phase produced an immediate and sustained reduction in the time Greg allocation to mirror viewing (M = 0.85%), an initial reduction in vocalizations (M = 43.56%) that eventually increased to moderately high levels, low to moderate levels of thumb sucking (M = 10.73), low but stable levels

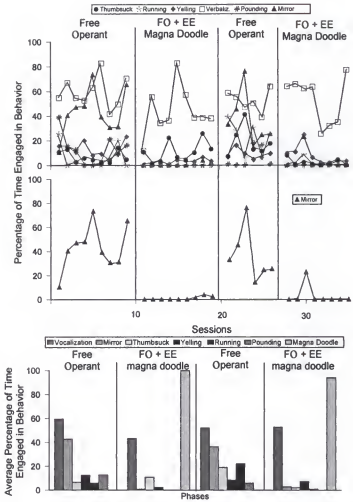


Figure 4-3. Percentage of time Greg allocated to all response forms (top panel) and mirror viewing (middle panel) during FO and FO+EE Magna Doodle phases. Average percentage of time allocated to stereotypy and the magna doodle during FO and FO+EE Magna Doodle phases (bottom panel).

of yelling ($M = 2.36$), and no running or pounding. A return to FO produced a high and stable levels of vocalizations ($M = 52.31\%$), an immediate increase to high levels of mirror viewing ($M = 36.42\%$) during the first three sessions that decreased to moderate, stable levels for the last three sessions, variable levels of running ($M = 22.28\%$), thumb

sucking (M = 19%), and pounding (M =5.92%), and relatively low, stable levels of yelling (M = 8.52%). The second FO+EE Magna Doodle phase produced variable levels of vocalizations (M = 53%), the absence of mirror viewing for seven of the eight sessions (M = 2.85%), low, stable levels of yelling (M = 7.42%) and running (M = 1.04%), and no pounding.

Figure 4-3 (middle panel) shows the percentage of time that Greg allocated to mirror viewing across the FO and FO+EE Magna Doodle phases. Greg exhibited moderate to high levels of mirror viewing during the 15 sessions in the FO phase; however, levels of mirror viewing were zero or near zero for 16 of 17 sessions during the FO+EE Magna Doodle phase. Figure 4-3 (bottom panel) shows the mean percentage of time that Greg allocated to stereotyped behaviors across to the FO and FO+EE Magna Doodle phases. In general, this panel shows that Greg consistently allocated the most time to vocalizations during FO and FO+EE Magna Doodle. Greg allocated the second most time to mirror viewing during FO; however, the addition of the magna doodle shifted preference (in terms of time allocation) such that magna doodle (M = 100%) was the most preferred event. This pattern was replicated in the subsequent FO and FO+EE Magna Doodle phase with a slight reduction in time allocation to the Magna Doodle (M = 93.97%). Although Geff's time allocate to running or pacing was low during FO was low, he consistently spent even less time engaged in both behaviors during FO+EE Magna Doodle.

Figure 4-4 (top panel) shows the percentage of time that Greg allocated to stereotyped behaviors during the FO+EE Music and FO phases. During the first FO+EE Music phase, Greg allocated moderate to high levels of time to vocalizations (M = 27.9%) and thumb sucking (M = 25.11%), moderate levels of time to running (M = 13.19) and mirror

viewing (M = 10.6%), and low levels of time to yelling (M = 3.42%) and pounding (M = 0.83%). Introduction of the FO phase increased time allocation to vocalizations (M = 59%), running (M = 35%), and pounding (M =6.28%), decreased in time allocation to thumb sucking (M =15.27%), but produced little change in levels of mirror viewing (M = 11.17%) and yelling (M = 3.39%). Introduction of the second FO+EE Music phase produced gradual decreases in time allocation to vocalizations (M =26.46%) and running (M = 27.5%) and generally low levels of mirror viewing (M = 6.67%), yelling (M = 6.37%), pounding (M = 5.25%), and thumb sucking (M = 3.33%). The second FO phase produced increased time allocation to vocalizations (M = 43.44%), an initial increase in mirror viewing (M = 20.78%), which was followed by a decrease to zero, a slight decrease in time allocation to running (M = 17.11%), and low levels of time allocation to pounding (M = 6.27%), thumb sucking (M = 5%), and yelling (M = 3.6%).

Figure 4-4 (middle panel) shows the percentage of time Greg allocated to vocalizations. Greg allocated at least 50% of his time to vocalizations during five of the six sessions in the FO phase compared to only one session in the FO+EE Music condition. During the FO+EE Music condition, 40% or less of Greg's time was allocated to vocalizations in 13 of 15 sessions.

Figure 4-4 (bottom panel) shows the mean percentage of time Greg allocated to stereotyped behavior across the FO+EE Music and FO phases. Unlike the previous evaluation, data were not collected on "music manipulation" because music was freely available to Greg during the FO+EE Music sessions (i.e., an operant was not required to access the auditory stimulation). During the first FO+EE Music phase, Greg allocated the

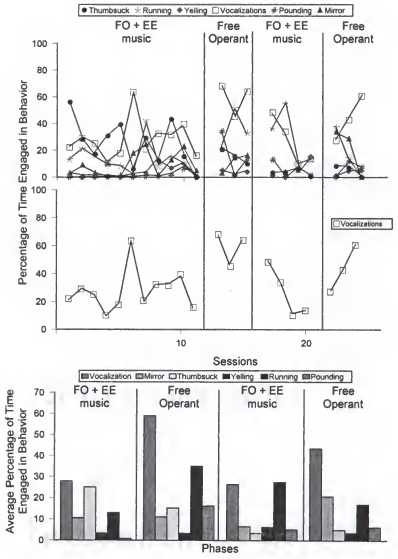


Figure 4-4. Percentage of time Greg allocated to all stereotyped response forms (top panel) and vocalizations (middle panel). Average percentage of time allocated to stereotyped behavior during FO+EE music and FO phases (bottom panel).

most and second most time to vocalizations and thumb sucking, respectively, followed by running and mirror viewing. In the first FO phase, vocalizations continued to be the most preferred response, while running and pounding both increased to become the second and third most preferred responses, respectively. In the second FO +EE Music phase, running became the most preferred response by a narrow margin, while vocalizations became the

second most preferred response. In the second FO phase, vocalizations were again the most preferred response followed by mirror viewing and running. In general, lower levels of vocalizations were observed during FO+EE Music than during FO; however, vocalizations was a highly preferred response across both phases.

Figure 4-5 (top panel) shows the percentage of time that Greg allocated to stereotyped behavior during FO and FO+EE MDM phases. The first FO phase, which was also the second FO phase in the previous evaluation (i.e., FO vs. FO+EE Music), produced relatively high levels of time allocation to vocalizations, moderate levels of time allocation to mirror viewing and running, and low levels of allocation to pounding, thumb sucking, and yelling. The first FO+EE MDM phase produced a gradual reduction in time allocation in vocalizations to a moderate level (M = 22.8%), a gradual reduction in allocation to mirror viewing (M = 4.4%) to zero or near-zero levels, and initial decreases in time allocation to running (M = 10.3%) that ultimately increased during the last session. The subsequent FO phase was marked by increased time allocation to vocalizations (M = 51.11%), thumb sucking (M = 22.6%), and pounding (M = 17%), and relatively low and unchanged levels of yelling (M = 7.05%), mirror viewing (M = 6.61%), and running (M = 5.28%). In the final FO+EE MDM phase, the percentage of time Greg allocated to vocalizations (M = 33.09%), thumb sucking (M = 4.25%), pounding (M = 0.01%), and mirror viewing (M = 0.05%) decreased, while time allocation to running and yelling remained relatively low (Ms = 3.45% and 2.3%, respectively).

Figure 4-5 (middle panel) shows the percentage of time that Greg allocated to mirror viewing and vocalizations (the stereotyped behaviors that decreased during the prior EE

conditions). In the first FO phase, levels of mirror viewing were moderate during the first two sessions and then decreased to zero. During the ensuing FO+EE MDM phase, time

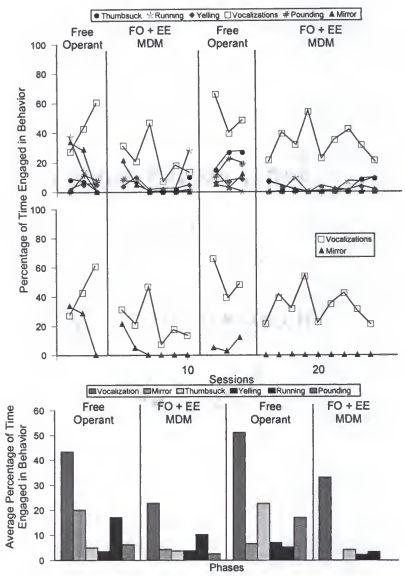


Figure 4-5. Percentage of time Greg allocated to all stereotyped response forms (top panel) and vocalizations and mirror viewing (middle panel). Average percentage of time allocated to stereotyped behavior during FO and FO+EE MDM phases (bottom panel).

allocation to mirror viewing increased for one session and then rapidly decrease to zero for four of the six sessions. Time allocation to mirror viewing increased slightly to low levels during the second FO phase and then decreased to zero or near-zero levels for nine

sessions in the last FO+EE MDM phase. In general, levels of vocalizations were moderate to high (or increasing) during FO and moderate to low (and decreasing) during FO+EE MDM.

Figure 4-5 (bottom panel) shows the mean percentage of time Greg allocated to stereotyped behavior during the FO and FO+EE MDM phases. During the first FO phase, vocalizations was the most preferred response, followed by mirror viewing and running. In the first EE+FO MDM phase, vocalizations decreased but remained the most preferred, followed by running, which also decreased substantially from the prior phase. In the second FO phase, vocalizations increased and remained the most preferred response; thumb sucking and pounding both increased to become the second- and third-most preferred behaviors. In the final FO+EE MDM phase, vocalization decreased but remained the most preferred response. Although reductions were noted for Greg's other stereotyped response forms, inconsistent and low time allocation made it difficult to determine further preference for these behaviors.

Discussion

The effect of EE on the stereotyped behavior of three individuals was evaluated. The results showed that EE produced a different outcome for each participant. For Alice, EE, which include a broad selection of objects, increased her manipulation of several different objects and decreased engagement in her preferred stereotypy. By contrast, Geff's behavior was unchanged by comparable provisions of alternative stimulation. For Greg, EE involving either the magna doodle or music reduced a single stereotyped response that putatively produced stimulation that was similar to the enriching stimulus. Thus, the short-term effectiveness of EE for reducing stereotyped behaviors was demonstrated for two of the three participants.

Geff and Alice were both exposed to a wide range of stimuli during EE, whereas Greg was provided stimuli that were matched to the presumed products of his stereotyped behavior. For Alice, EE appeared to evoke some behavior (e.g., toy manipulation) that was incompatible with pacing (the most preferred response during FO). Despite the similarity in the procedures for Geff and Alice, the EE intervention had little if any effect on Geff's behavior. Geff's interaction with the alternative stimuli was limited to clearing a space on the floor where he sat and engaged in stereotypy. Nonetheless, the general reductions in Alice's stereotyped behavior produced with EE are consistent with previous studies (e.g., Vollmer et al., 1994). Unlike previous research, however, these reductions were modest and the presence of alternative objects did not change Alice's preference for or the ordering of stereotyped behavior (it simply decreased her time allocation to the most preferred response). Thus, despite the robust reductions in stereotyped behavior that were produced with EE for Alice, one could argue that EE was not an effective intervention for her behavior.

For Greg, who was exposed to a very narrow range of stimulation, the effects of EE appeared to be specific to the type of stimulation that could be derived from the object. Patel et al. (2001) and Wilder et al. (2002) decreased single topographies of stereotypy with matched stimuli; however, individuals in these studies exhibited only one form of stereotypy. Thus, compared to the results of Patel et al. and Wilder et al., the present experiment (i.e., the behavior to which the stimulus was matched decreased while others were relatively unchanged) provides stronger evidence for explaining behavior reductions in terms of stimulus substitution as opposed to stimulus competition because only one behavior decreased in the presence of either the magna doodle or the music.

Although some potentially interesting features of enriched environments were elucidated in the present experiment, it is not clear why behavior reductions were obtained for Alice and Greg, but not for Geff. More specifically, between subjects analysis of the two EE responders suggests that there is not a direct relationship between the number of stimuli presented during EE and the reduction in stereotyped behavior obtained therein. Geff was provided only one alternative sources of stimulation (magna doodle or music) during EE, thus any reductions from baseline obtained during these sessions are likely attributable to stimulation generated from the object. By contrast, Alice had access to several items during EE; however, data suggest that time allocation to alternative sources of stimulation was erratic within a given session and inconsistent across phases (i.e., order of preference for the "enriching stimuli" changed). Hence, for Alice, it is likely that the effects of EE would have been less pronounced with fewer stimuli. It is also interesting to note that even though two of the toys provided during EE produced various audible products (e.g., songs from the keyboard that may have competed with stereotypy), Alice's vocalizations were relatively unchanged across phases. This outcome is in direct contrast to the effects produced during FO+EE Music for Greg's vocalizations. Thus, the effects of EE on the stereotyped behavior of Greg and Alice were likely idiosyncratic.

The results of Greg's analyses seem particularly important for determining whether EE provides stimulation that substitutes for, is equivalent to, or competes with the products of automatically reinforced behavior. The most compelling evidence for a substitution or equivalence explanation is the selective reductions in stereotyped behavior that were produced with the magna doodle and the music. Specifically, the two most

preferred responses were separately decreased without producing general changes to Greg's repertoire. The stimulation provided during EE matched the products of the behaviors that were reduced: The magna doodle reduced a behavior that was presumably maintained by visual stimulation and music reduced a different behavior that previously generated an auditory product.

A recent study by Rapp, Dozier, Carr, Patel, and Enloe (in press) showed that mirror viewing and erratic body movements that was exhibited by a boy with autism was maintained by the visual stimulation that was produced on reflective surfaces. Rapp et al. showed that the boy had a preference for visual stimulation that he could control and, therefore, concluded that mirror viewing was maintained by visual stimulation on a conjugate schedule of reinforcement. It is possible that the magna doodle provided Greg this same kind of control over visual stimulation, which may have been less effortful than and more reinforcing (by virtue of restricted access) than mirror viewing. Conversely, auditory stimulation from the radio was not controllable by Greg (e.g., he could not increase or decrease the volume). The absence of control over reinforcement may explain why reductions obtained with the FO+EE Music condition were less pronounced than those produced with the FO+EE Magna Doodle condition. Consistent with this position, Greg also displayed low levels of ear hitting during the music condition and, likewise, occasionally attempted to increase or decrease the volume of the music. Both behaviors could have functioned to alter the magnitude of the auditory stimulation. It should be noted that ear hitting was reduced to near-zero levels during the FO+EE MDM condition.

Examination of phase means from the FO+EE Magna Doodle analysis reveals that orderly changes in other repetitive behaviors were also produced with the magna doodle

intervention. Most notably, pounding was absent and levels of running were substantially reduced when the magna doodle was available. Although such reductions are clinically desirable, it is not clear what operant mechanism(s) account for these changes in response allocation. The most parsimonious explanation is that the stimulation produced by the magna doodle was very potent and, therefore, competed with Greg's engagement in behaviors with less potent products (e.g., Greg could not engage in running while drawing on the magna doodle).

Following the analysis of the FO+EE Magna Doodle condition, it is not clear why levels of mirror viewing during the evaluation of the FO+EE Music condition did not recover to previously observed levels. It is possible that the prior analysis produced satiation for visual stimulation produced by both mirror viewing and the magna doodle. Instead, time allocation to running, which was largely incompatible with mirror viewing, increased in its place. Prior research has shown (see also experiment 1) that time allocation to a restricted response often increases above previous free operant levels when it is subsequently permitted (e.g., Forehand & Baumeister, 1971; 1973; McIntee & Saunder, 1997; Patel et al., in press; Rollings & Baumeister, 1982). Because running was substantially reduced during the FO+EE Magna Doodle condition, this condition may have imposed deprivation for the product(s) of running (Klatt & Morris, 2002).

Geff's time allocation to stereotypy during EE and FO was nearly identical in terms of time and ordering of responses. The relative insensitivity of Geff's behavior to the alternative stimuli suggests that the items were not potent reinforcers when stereotyped behavior was available. Although data were presented on only the four most preferred behaviors, EE manipulation did not produce changes in less preferred behavior because

Geff allocated almost no time to the enriching stimuli. It is possible that Geff's behavior could have been reduced if a wider array of stimuli had been present; however, the present results suggest that this too would have been unlikely as Geff contacted the alternative stimuli only briefly when he cleared a spot on the floor where he then sat and engaged in stereotypy. Anecdotal reports and informal observations indicated that Geff did engage in some appropriate object manipulation on a daily basis, but these manipulations did not appreciably decrease his stereotypy (e.g., Geff frequently kicked balls while rubbing his hands and snorting). Thus, the sheer number of repetitive response forms displayed by Geff makes effective treatment with EE problematic insofar as Geff's repetitive behavior may have produced a wide range of stimulation. Similarly, anecdotal reports suggested that engagement with any one toy was still likely to be accompanied by one or more forms of stereotypy (Geff often exhibited as many as three stereotyped behavior simultaneously).

A general limitation to the present analysis was the brevity of the sessions in the phases involving enriching stimuli. In some sense, these sessions were like a free operant stimulus preference assessment because alternative sources of reinforcement from stereotyped behaviors were concurrently available (Ringdahl et al., 1997; Roane et al., 1998). A potential problem is that the behavior change produced in relatively brief sessions may not represent behavior allocation across extended periods of time. Vollmer et al. (1994) suggested that the effects of EE on repetitive behavior might be transient or temporary due to reinforcer satiation (i.e., degradation of the reinforcer effect of the alternative stimuli). This possibility, coupled with the observation that stereotypy reductions for both Alice and Greg are best described as modest (and EE did not affect

Geff's behavior), suggests that supplementary interventions may be necessary to increase the effectiveness of EE as a treatment for stereotypy (e.g., Lindberg et al., 1999). Furthermore, for individuals whose stereotypy is relatively insensitive to EE, it may be necessary to develop an alternative response repertoire.

CHAPTER 5
FACILITATING RESPONSE REALLOCATION DURING EE

A number of behavioral interventions have been used to facilitate appropriate toy interactions in order to replace or compete with stereotyped behavior. For example, Eason, White, and Newsom (1982) and Greer, Becker, Saxe, and Mirabella (1985) reduced the stereotyped behavior of children with autism by providing social (verbal praise) and edible reinforcement contingent on appropriate toy play. Both studies demonstrate the persistence of appropriate behavior persisted for several months after the additional contingencies were withdrawn. However, it should be noted that Eason et al. (1982) and Greer et al. (1985) used "physical redirection" or "interruption" contingent on any stereotyped response; both of these could be construed as a form of response restriction or punishment. Wells, Forehand, Hickey, and Green (1977) decreased stereotyped behavior and increased appropriate toy play using contingent overrcorrection (i.e., positive practice), which involved physical assistance to play with the toy (for a specified period of time) contingent on any stereotyped response. Based on results from the Wells et al. (1977) study, the use of edible reinforcers in the Eason et al. (1982) and Greer et al. (1985) studies may have been an unnecessary component as toy play may have increased when stereotypy was blocked (see Hanley et al., 2000).

In an attempt to replicate previous findings with EE (e.g., Favell, McGimsey, & Schell, 1982), Lindberg et al. (1999) examined the effects of supplementing EE with prompting, differential reinforcement, and response blocking to increase object manipulation and decrease "stereotypic" self-injurious behavior (SIB) by two individuals.

Lindberg et al. found that the mere availability of alternative stimuli (identified via stimulus preference assessment) during EE was insufficient for reducing stereotypic responding. Instead, both participants required the addition of prompts (verbal and physical) to increase object manipulation during EE. Unlike previous studies (e.g., Singh & Millichamp, 1987), increases in object manipulation were not inversely correlated with reductions in stereotypy (i.e., individuals simultaneously engaged object manipulation and repetitive SIB). In addition, contingent access to preferred edibles for object manipulation did not produce further changes in stereotypy or object manipulation. Subsequently, response blocking was required to decrease stereotypy and increase object manipulation for one participant, while application of arm restraints was needed to facilitate these same changes in the other participant. Thus, Lindberg et al. showed that restricted access to stereotypy (and its consequence), as well as additional reinforcement for object manipulation, was needed before object manipulation was exhibited. As noted by Lindberg et al., it is possible that availability of "matched" stimulation may have facilitated behavior allocation to objects without physical restriction of stereotypy.

Consistent the results of Lindberg et al. (1999), Hanley et al. (2000) found that physical prompts neither increased object manipulation nor decreased stereotypy for three individuals. However, in contrast to Lindberg et al. (1999), Hanley et al. (2000) subsequently found that providing prompts while restricting access to stereotypy substantially increased object manipulation for two participants. Thus, when stereotypy and its product(s) were unavailable, manipulation of objects generated stimulation that functioned as reinforcement. A more recent study by Lerman et al. (in press) found that restricting access to stereotypy (via response blocking) during EE actually decreased

appropriate toy play and increased allocation to another stereotypic behavior. Lerman et al. speculated that because stereotypy and toy play were often exhibited simultaneously, it is possible that toy play was adventitiously punished. Thus the individual reallocated responding to another, unpunished form of stereotypy. In short, restricted access to a stereotypic behavior during EE does not necessarily predict reallocation to appropriate behavior.

It is not clear why additional reinforcement may be required to occasion appropriate behavior for some individuals and not for others. For individuals who have a history of appropriate object manipulation, restricting access to stereotypy may be sufficient to occasion appropriate object interactions. Conversely, individuals who do not already manipulate objects appropriately may require additional techniques, such as response interruption, prompts to initiate object interactions, and supplemental contingencies of reinforcement, to facilitate object manipulation.

The primary purpose of experiment 3 was to extend research on the use of EE and supplemental interventions to decrease stereotyped behavior. In experiment 3, two different procedures were used to increase object manipulation under conditions of an enriched environment. Alice and Geff (see experiment 2) were selected to participate because each displayed relatively high levels of stereotyped behavior during EE. However, because Alice engaged in some appropriate object interactions during EE (i.e., she had a history of appropriate object manipulation), we restricted access to her most preferred stereotyped behavior in an attempt to shift her response allocation to appropriate stimuli. Specifically, only pacing was restricted during EE while all other stereotyped behaviors were permitted. By contrast, because Geff displayed almost no

appropriate object manipulation (i.e., toy play was not a part of his repertoire), a procedure involving prompting and differential reinforcement for toy play was used during EE. Given the change in response allocation that was observed during the RR assessments in experiment 1, a secondary purpose of the present study was to further evaluate the effects of response allocation to stereotypy following the removal of the respective interventions.

Method

Participants

Geff and Alice participated in the present experiment. The settings, target behavior, and data collection were the same as described in experiment 1. The effects of two different interventions, for increasing object manipulation and decreasing stereotypy, were evaluated for Geff and Alice.

Procedures and Design

For both participants, the effects of EE plus an additional intervention were evaluated using a reversal design. The participants' target behaviors were assessed using the methods described in Chapter 2. The percentage of time Geff and Alice allocated to the alternative stimuli during the experimental conditions was also recorded. For Geff and Alice, object manipulation was defined as any contact of the participant's fingers with the object. In addition, toy responses were defined as contact of either of Geff's hands with a toy that resulted in an audible product (e.g., pressing a key on a keyboard so that it produced a sound). Consequences were provided for toy response only (i.e., reinforcement was not provided for simply touching toys). Based on these definitions, each "toy response" by Geff was also scored as object manipulation. It was possible for Geff or Alice to simultaneously engage in multiple stereotyped behaviors, multiple

appropriate behaviors, or a combination of both stereotyped and appropriate behaviors. IOA scores for Geff's and Alice's respective stereotyped behaviors are depicted in Table 2-2. A second observer scored at least 30% of the sessions. IOA was calculated in the same manner as described in Chapter 2. For Geff and Alice, IOA scores for object manipulation and toy responses (Geff only) were above 90%.

The *FO plus Enriched Environment (FO+EE)* condition was same as described in experiment 3 for Alice. For Geff, this condition was also the same as described in experiment 3 with the exception that two more toys were added. The toys that were added were equipped with keys and buttons that produced sounds when pressed. During this condition, neither the discriminative stimulus for reinforcer delivery (i.e., a therapist standing near the toys) nor juice was present. For both participants, this condition served as the baseline with which behavior changes produced with the other treatment conditions could be compared.

During the *EE+R*^{1} condition (Alice only), Alice was provided access to the same stimuli that were available during FO+EE. In addition, access to pacing, which was previously identified as Alice's most preferred stereotypy (see results of experiment 1), was restricted. Pacing was restricted using the same procedure described in experiment 1.

During the *EE+Fixed Ratio 1 Toy Play (EE+FR1 Toy Play)* condition (Geff only), the environment was identical to that described in the FO+EE condition and toy responses were reinforced on a FR 1 schedule with drinks of juice (i.e., a 2-second drink from a bottle of juice). Because Geff did not engage in toy responses independently, a three-step prompting sequence involving verbal, gestural, and physical prompts were used for several sessions until Geff acquired the toy-play response(s).

Results

Figure 5-1 shows the percentage of time Alice allocated to stereotyped behaviors and object manipulation during the FO+EE and EE+R[1] phases. Figure 5-1 (top panel), shows that Alice allocated the highest proportion of time to pacing (M = 40.9%), object manipulation (M = 26.49%) and vocalizations (M = 20.14%), and lower proportions to clothing manipulation (M = 12.9%) and carpet rubbing (M = 4.7%) (this was also the third phase in experiment 2). The implementation of EE+R[1] produced an immediate suppression of pacing, moderate and slightly increasing levels of vocalizations (M = 37%), gradually increasing levels of object manipulation (M = 60%), near-zero levels of clothing manipulation (M = 0.33%) and no carpet rubbing. The re-introduction of the FO+EE phase (i.e., removal of the pacing restriction) was marked by an increase in pacing in the first session, a sharp decrease in pacing during the second session, and a rapid increase in pacing to high levels for the remaining three sessions (M = 54%). During the same condition, object manipulation (M = 16%) decreased to low or moderate levels, vocalizations (M = 40%) persisted at relatively moderate levels, clothing manipulation slowly increased to moderate levels (M = 25.5%), and carpet rubbing (M = 4.04%) increased slightly but remained at low levels. Reintroduction of EE+R[1] resulted in the immediate suppression of pacing, moderate and slightly increasing levels of vocalizations (M = 42.33%), increased, but variable, levels of object manipulation (M = 31.45%), low levels of clothing manipulation (M = 5.66%), and no carpet rubbing.

Figure 5-1 (second panel) shows the percentage of time Alice allocated to vocalizations and object manipulation across the FO+EE and EE+R[1] phases. In the first EE+R[1] phase, the percentage of time Alice allocated to object manipulation was moderate to high across all six sessions. During the second FO+EE phase, object

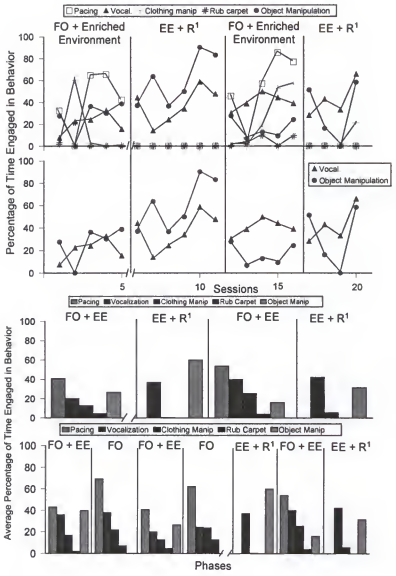


Figure 5-1. Percentage of time Alice allocated to all stereotyped response forms (first panel) and vocalizations and object manipulation (second panel) during FO+EE and EE+R^1 phases. Average percentage of time allocated to stereotypy and object manipulation across FO+EE and EE+R^1 phases (third panel) and across experiments 2 and 3 (bottom panel).

manipulation decreased substantially and did not exceed 30% during any session during this phase. In the second EE+R^1 phase, Alice's time allocation to object manipulation initially increased, but then decreased during the second session and was zero during the third session. Note that prior to session 14 that Alice had taken medication for which a

known side effect was sedation. Ultimately, time allocation to object manipulation increased to a moderate level during the fourth session of this phase. Overall, time allocation to object manipulation during the EE+R^1 phase exceeded levels observed in FO+EE during 8 of 10 sessions (including the session where Alice was taking medication). In general, time allocation to vocalizations was slightly variable during the first EE+R^1 phase, relatively stable during the FO+EE phase, and increased slightly during the last session of the second EE+R^1 phase. Thus, time allocation to object manipulation was higher when pacing was restricted, whereas time allocation to vocalizations was relatively unchanged across phases.

Figure 5-1 (third panel) shows the mean percentage of time Alice allocated to stereotypy and object manipulation across the FO+EE and EE+R^1 phases. Data in the third panel indicate that Alice's most preferred response during EE+R^1 was object manipulation (as a class of responses) followed by vocalizations. During FO+EE, pacing became the most preferred response followed by vocalizations, clothing manipulation, and then object manipulation. Following the re-implementation of EE+R^1, vocalizations became the most preferred response followed by object manipulation and clothing manipulation.

Figure 5-1 (fourth panel) shows the phase means from the previous FO and FO+EE assessment (from experiment 2) in addition to the phase means from the present experiment. Data in the fourth panel indicate that the ordering of Alice's preference for stereotypy in the present FO+EE phase was consistent with the ordering observed in the FO+EE phases that were conducted in experiment 2. However, Alice allocated substantially more time to pacing and considerable less time to object manipulation

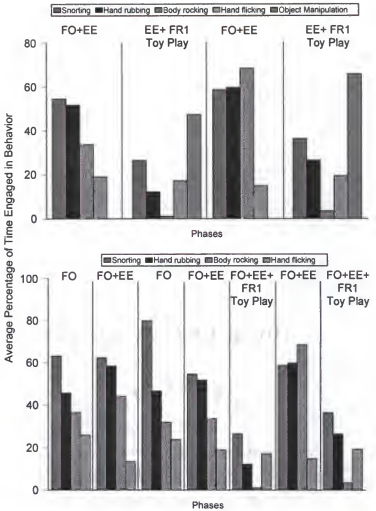


Figure 5-2. Average percentage of time Geff engaged in snorting, hand rubbing, body rocking, hand flicking, and object manipulation during FO+EE and FO+EE+ FR1 Toy Play phases (top panel). Average percentage of time engaged in snorting, hand rubbing, body rocking, and hand flicking across experiments 2 and 3 (bottom panel). The fourth panel also shows that vocalizations were on a slightly increasing trend across successive phases and that carpet rubbing was suppressed during EE+R^1.

during the FO+EE phase that followed the EE+R^1 phase in the present experiment. The

Figure 5-2 shows the mean percentage of time Geff allocated to stereotyped behavior and object manipulation and the FO+EE and FO+EE+FR1Toy Play phases. The top panel of Figure 5-2 shows the mean percentage of time that Geff allocated to his four most preferred stereotyped behaviors (based on means of FO and FO+EE phases) and object

manipulation. In the first FO+EE phase (this was also the second FO+EE phase from experiment 2), Geff allocated the highest proportion of time to snorting (M = 54.6%) and hand rubbing (M = 51.75%), and lower proportions to body rocking (M = 33.72%) and hand flicking (M = 18.99%). In the first EE+FR1 Toy Play phase (N =14 sessions), Geff allocated the highest proportion of time to object manipulation (M = 47.33%), followed by snorting (M = 26.5%), hand flicking (M = 17.15%), hand rubbing (M = 12.14%), and body rocking (M = 1.1%). During the second FO+EE phase (N = 3 sessions), Geff allocated the highest proportion of time to body rocking (M = 68.45%), followed by hand rubbing (M = 59.77%), snorting (M = 58.67%), and hand flicking (M = 14.83%). Geff did not allocate time to object manipulation during FO+EE phase. In the second EE+FR1 Toy Play phase (N = 16 sessions), Geff allocated the highest proportion of his time to object manipulation (M = 65.87%), followed again by snorting (M = 36.37%),hand rubbing (M = 26.48%), hand flicking (M = 19.31%), and body rocking (M = 3.46%). In general, object manipulation (and its consequences) was the most preferred response during EE+FR1 Toy Play, but was the least preferred response during FO+EE. By contrast, body rocking was the most preferred behavior during FO+EE and the least preferred (of the five behaviors listed here) during FO+EE.

Figure 5-2 (bottom panel) depicts the mean percentage of time that Geff allocated to the four most preferred stereotyped behaviors across the previous FO and FO+EE phases (from experiment 2) in comparison to the present experiment. The bottom panel shows that the percentage of time Geff allocated to body rocking during the first four phases (i.e., FO, EE, FO, and EE) was relatively stable; however, time allocation to body rocking decreased substantially during the first EE+FR1 Toy Play phase, increased above

previously observed levels during the subsequent EE phase, and decreased again during the second EE+FR1 Toy Play phase. Thus, Geff exhibited the high levels of body rocking in the EE phase that followed an intervention, which substantially decreased body rocking. Figure 6-6 also shows that levels of snorting and hand rubbing decreased during the first EE+FR1Toy Play phase; however, neither behavior increased above previously observed levels during the ensuing EE phase. Last, bottom panel of Figure 5-2 shows that Geff's time allocation to hand flicking was relatively unchanged across all seven phases.

Discussion

Two different approaches for facilitating response reallocation to object manipulation were used in the current experiment. For Alice, restriction of her most preferred stereotyped response yielded increased time allocation to object manipulation above that which was achieved during FO+EE (i.e., without restriction of pacing). For Geff, provisions of reinforcement for toy responses also increased time allocation to an alternative stimulus and simultaneously decreased Geff's three most preferred response forms.

Both of the interventions used in the present study decreased stereotyped behavior and increased object manipulation; however, it is likely that the operant mechanism that was responsible for behavior change in the respective participants was very different. For Alice, withholding access to pacing (the most preferred stereotypy) presumably set the occasion for stimuli to evoke appropriate behavior that was reinforced by alternative sources of automatic reinforcement. By contrast, the reinforcement produced by Geff's stereotypy remained available, but was presumably overridden by stimulation (i.e., the drink) that was provided contingent on appropriate toy play, which presumably was momentarily more efficacious.

The results for Geff are particularly interesting because the juice contingency produced multiple reductions in stereotyped behavior (i.e., covarying reductions). As previously observed in experiment 1 (during the R^1 analysis), when levels of hand rubbing decreased, so did levels of snorting. However, unlike the prior experiment, changes in body rocking also coincided with changes in hand rubbing and snorting. Conversely, hand flicking appeared unaffected by the contingency. Given the number of stereotypies that were reduced during the EE+FR1 Toy Play intervention, it is difficult to offer a clear explanation of the responsible mechanism. Nevertheless, the results of the present experiment for hand rubbing and snorting are consistent with the outcome of experiment 1. Although hand rubbing, and to some extent body rocking, may have been incompatible with toy manipulation, snorting remained accessible to Geff. Despite the availability of snorting, it was substantially lower when object manipulation, which was topographically incompatible with hand rubbing, was reinforced with juice. Likewise, data from the four previous phases indicated that time allocation to snorting and hand rubbing was proportionally similar, suggesting that the behaviors were emitted simultaneously (as shown in experiments 1 and 2). It is possible that snorting decreased as an artifact of juice presentation because Geff could not snort and drink juice at the same time; however, Geff did not respond rapidly enough to receive continuous access to juice. Thus, he had ample opportunity to engage in snorting independent of or concurrent with object manipulation. It should be noted that the reinforcement schedule (i.e., juice delivery) for Geff's toy responses was eventually thinned to a conjoint schedule (fixed interval 60s/ FR30) and stereotypy reductions were maintained.

For both participants, removal of supplemental interventions during reversals produced increased levels of stereotypy. For Alice, pacing was higher during the EE phase that followed EE+R[1] than in previous EE phases. This increase in time allocation to pacing was inversely correlated with the lowest level of object manipulation in an EE phase. Thus, restricting pacing may have increased its reinforcing value and, by virtue of incompatibility of other responses, may have indirectly suppressed object manipulation.

During the FO+EE phase in the present experiment, Geff engaged in the highest levels of body rocking during any three consecutive sessions in any of the experiments. Based on data from experiments 1 and 3, body rocking was Geff's third-most preferred stereotyped behavior behind hand rubbing and snorting. Similar to the results for Alice, the data suggest that reinforcement of object manipulation may have indirectly prevented body rocking (i.e., the two responses were incompatible) and, thereby, created a relative state of deprivation for its product. It is possible that the deprivation imposed by reinforcement of an incompatible operant served to establish body rocking as a more potent source of reinforcement when object manipulation was no longer reinforced. To some extent, this outcome addresses a question posed in experiment 1 regarding the effects of restricting access to a less preferred behavior: Data from the present experiment indicate that time allocation to the restricted behavior increases when the referent behavior becomes unrestricted.

On a broader level, data for Geff are consistent with those of Baumeister and Forehand (1971), who found that body rocking of individuals with mental retardation decreased when level pulling was reinforced on FR1 or FR2, but subsequently increased above baseline levels when lever pulling was placed on extinction. Nonetheless, the

interpretation offered in the present experiment differs to the extent that of Baumeister and Forehand attributed this increase to "frustration" that was induced during extinction of an instrumental response.

The results of the present analysis may contribute to the literature in at least two ways. First, the analysis with Alice showed that response reallocation to appropriate object manipulation could be facilitated by restricting access to only the most preferred stereotyped behavior, as opposed to restricting each stereotyped behavior. Second, because data were collected on specific response forms, instead of stereotypy as a behavior class, the relative effects of the intervention on each stereotyped behavior could be examined. Similarly, the extent to which the effects of the intervention persisted and stereotypy resumed when the contingencies were withdrawn was also assessed.

Last, the present results for Alice are inconsistent with recent findings indicating that response restriction during EE with an individual who already displays appropriate toy play may actually reduce appropriate responding (Lerman et al., in press). It is possible that the outcomes differed because, unlike the individual in the Lerman et al. study, Alice was not typically engaged in appropriate toy play when access to pacing was blocked. In fact, the only other target behavior that Alice exhibited while pacing was vocalizations, which was unaffected by the intervention. Speculation about the operant mechanism of change notwithstanding, the present results suggest that withholding access to R^1 may increase allocation to appropriate behavior during EE.

CHAPTER 6
SUMMARY AND CONCLUSIONS

Experiment 1 first showed that each participant exhibited relative preference for a response form of stereotypy. For a majority of the participants, restriction of the most preferred response form resulted in consistent reallocation to a previously less preferred stereotyped response and a decrease in an untargeted (also highly preferred) response. Supplemental analyses of behavior-behavior relationships yielded significant positive correlations between the most preferred stereotyped response and the response with which it appeared to covary (based on visual inspection). Last, for some two participants, results showed that restriction of the most preferred response form produced an increase in time allocation to the restricted response when that response was permitted in the subsequent FO phase.

Experiment 2 evaluated the extent to which two variations of EE facilitated an increase in response reallocation to object manipulation (i.e., toy play) and a decrease in stereotypy. For the general EE condition, two participants were provided several items that, when manipulated, could have produced a wide range of stimulation (e.g., tactile, auditory). In the specific EE conditions, a third participant was provided only single items (one at a time) that were matched to putative response products of highly preferred stereotyped responses (e.g., visual stimulation). The results showed that general enrichment reduced multiple response forms for one participant, but produced no change in behavior for the other. Results for the single-item enrichment conditions showed that the single stimulus decreased time allocation to the stereotyped response with it was

matched, but did not change time allocation to other response forms. For both responders, EE produced the greatest reductions in the respective individual's most preferred response.

Experiment 3 evaluated the extent to which EE with two supplemental interventions increased object manipulation and decreased stereotypy. For one participant, restriction of the most preferred stereotyped response during EE increased response allocation to the enriching stimuli. For the other participant, reinforcement for toy play during EE increased object manipulation and simultaneously decreased several stereotyped response forms. When the supplemental procedures were removed (i.e., during EE alone), both participants showed increased time allocation (above the previous EE phase) to a response form that had decreased during the intervention.

The first experiment in this series was designed to determine whether preferences for stereotyped behavior could be identified. Once this initial question was addressed, the ensuing studies intended to evaluate the extent to which identified preferences could be altered using response restriction, competing sources of stimulation, and differential reinforcement for competing responses. The collective outcome of these experiments promotes at least three general themes and extends the literature in several ways. Of the more salient findings, these experiments show consistent time allocation to stereotyped behavior during free operant and restricted operant conditions (i.e., preference). Further, indirect changes in untargeted (covarying) behaviors were also demonstrated using restriction procedures, such as response blocking or verbal reprimands, contingent on the most preferred response form or using differential reinforcement for appropriate behavior.

Consistent with prior studies involving stimulus preference assessment (e.g., McEntee & Saunders, 1997; Hanley et al., 2002), the results from the present experiments showed that decreases in preferred response forms were correlated with increases in a previously less preferred response (either another stereotyped response or object manipulation). Subsequently, reversals to baseline yielded increased levels (above the initial baseline) of the most preferred response. This pattern suggests that deprivation for stimulation produced by the restricted response was imposed during the restriction condition and that the behavior to which responding was allocated did not generate a comparable product. By contrast, data from experiment 3 (for Greg) showed that EE produced selective reductions in stereotypy and, further, the subsequent re-introduction of baseline did not yield increased levels (above baseline) of the target stereotypy. These findings suggest that the alternative operant generated stimulation similar to that of the targeted stereotypy. In terms of providing treatment for stereotypy, these experiments provide a method with which changes in response allocation, which may include a concomitant decrease in an untargeted behavior or an increase in a previously less frequent but more problematic behavior, may be predicted following the introduction of a behavioral treatment.

Based on the behavior-behavior relationships that emerged for several participants during R^{I}, a second theme involves an expansion of the application of behavioral economics to automatically reinforced stereotyped behavior. Specifically, the current data suggest that the product or "commodity" of a stereotyped response forms became a more potent reinforcer when another commodity was simultaneously available. Within-session data (from the free operant condition) suggested that specific behaviors were typically

exhibited concurrently and statistical analyses further identified multiple, significant correlations between each individual's response forms. Supplemental analyses for statistically significant behavior pairs with conditional (i.e., occurrence of one event given another) and unconditional probabilities showed that; a) a significant correlation did not necessarily indicate that two responses occurred simultaneously, b) a higher conditional than unconditional probability indicated that one response form became more likely when other was already occurring (supporting a complimentarity explanation), and c) a higher unconditional that conditional probability was likely indicative of a negative correlation between the two behaviors. The combination of these outcomes suggests that restriction of the most preferred response form altered preference for other behavior in a very complex way.

Future Research

Results from current experiments set the occasion for future investigations involving preference for stereotypy, the effects of response deprivation on automatically reinforced behavior, qualitative dimensions of the stimulation generated by stereotyped behavior, and influences of social reinforcement on stereotyped behavior. On a general level, further research is needed to further evaluate the validity and utility of identifying preferences for stereotyped behavior. Data from the current experiments suggest that relative preference for stereotyped response forms can be readily identified during FO conditions, but no specific criteria or heuristics were isolated for determining such preference (e.g., length of sessions). During free operant sessions, it is interesting to note that the response form that was exhibited first typically became the response that was designated R^1 (i.e., was the most preferred response). This same pattern also described time allocation for the next most preferred responses. If the immediacy of behavior

allocation is valid indicator reinforcer efficacy, then preference for stereotyped behavior could potentially be determined by observing the order of an individual's response allocation to a fixed number of response forms (e.g., the first five behaviors) during a relatively brief period of time (in this case, just enough time to observe five distinct responses); thereafter, relative preference could be inferred from the order of allocation (see DeLeon & Iwata, 1996). Research is obviously needed to determine the clinical necessity of identifying preference for stereotypy and, thereafter, the predictive utility of the procedure described above.

As previously indicated, results from experiments 1 and 3 suggest that interventions, which reduced a specific stereotyped response, may impose deprivation for the stimulation produced by the respective response. The collective outcome of these studies suggests an approach for more closely evaluating the operant mechanism that may be involved in behavior change in future studies. Essentially, this approach involves close examination of changes in response allocation during reversals to baseline. A recent study by Britton, Carr, Landaburu, and Romick (2002) provides an opportunity to describe this potential application. Britton et al. compared the effects of NCR (containing a highly preferred item) with and without prompts (this condition served as a baseline as it, alone, did not reduce stereotypy) on the stereotyped behavior of three individuals. The results showed that the percentage of time that each participant allocated to stereotyped behavior decreased during NCR (i.e., environmental enrichment) with prompts; however, stereotypy increased slightly above previous baseline levels for two participants when prompts were removed. Based on experiments 1 and 3, these increases suggest that some level of deprivation for stereotypy was imposed by the intervention, thereby indicating

that NCR (with prompts) did not necessarily generate stimulation that was similar to that produced by stereotypy.

Broad changes in response allocation that occur following the restriction of one response are clinically important and conceptually interesting. For most participants in the current experiments, restriction of one response produced substantially changes in time allocation to multiple responses (increases and decreases). Of particular note is the reduction in untargeted behaviors, which occurred when the most preferred response was restricted. Reductions in untargeted response have been reported in prior studies (Friman & Hove, 1988; Rollings et al., 1977; Rollings & Baumeister, 1981); however, little attention has been given to exploring the mechanism responsible for the covaried reductions. It is possible that the concurrent exhibition of specific responses may be explained in terms of reinforcer complimentarity (e.g., Green & Freed, 1993). That is, engagement of two responses, simultaneously, may generate a stimulus that is a more potent reinforcer than engagement in either of the two behaviors alone. An explanation involving complimentary reinforcement requires a bilateral analysis of the two responses in question. A problem inherent of the current study is that only one (the most preferred) response was restricted for each participant. Therefore, future research should evaluate the effects of restricting the response that decreased during R^1. If restriction of the "covaried" response also reduces the most preferred response, significant support for a complimentarity explanation could be generated.

Although the focus of the present experiments was to determine preference for stereotypy, rather than preference for the stimulation generated by stereotypy, experiment 3 showed that the use of "matched stimuli" (e.g., Piazza et al., 1998) during EE reduced

stereotyped responding. Specifically, the response form that generated a putative product that was similar to the stimulation provided by the alternative activity (e.g., listening to music or drawing) was reduced. Conclusions regarding the "selective" effects of the specific items are supported by the absence of changes in other response forms within and across phases (i.e., no increases in behavior were observed following reversals to baseline). However, it is not clear as to what dimension(s) of the enriched environment (e.g., the magna doodle) was responsible for altering response allocation (i.e., preference). Specific features of the magna doodle (matched stimulus) could have been further evaluated by altering Greg's control over the visual product of his drawing. Previous research suggests that preference for a presumed automatic reinforcer is governed, at least in part, by the individual's ability to control the some dimensions of the respective product (Berkson, 1998; Buyer, Berkson, Winnega, & Morton, 1987; Rapp et al., in press).

For example, Rapp et al. (in press) used a combined paired-choice and conjugate reinforcement procedure to evaluate the erratic body movements (EBM) and the accompanying observing behavior (i.e., orienting toward a stimulus) that were exhibited by an individual in the presence of reflective surfaces. The individual displayed a stronger preference (as evidenced by more EBM and observing) for visual stimulation that he controlled with his body movements than for visual stimulation that was yoked from his past behavior and presented noncontingently. Thus, when the results of the previous studies are placed within the context of Greg's behavior (with respect to response allocation to the magna doodle and mirror viewing), it is reasonable to suspect that the toy would have been less reinforcing (and thereby less effective for decreasing

mirror viewing) if he had not been in control of the stimulation that was generated by drawing (e.g., if he was only permitted to watch someone else draw). Given the possible influence of "control" in perceptual reinforcement, researchers should explore the use of conjugate reinforcement schedules in the analysis and treatment of stereotyped behavior.

Further research is needed to evaluate the procedures that are used to alter preference for appropriate activities/object manipulation. Experiment 3 showed that EE alone was a relatively ineffective intervention for reducing the stereotypy of two individuals, thus necessitating the use of additional procedures to shift response allocation toward appropriate behavior. An important component of the supplemental intervention (for one individual) was the delivery of an edible item (i.e., a primary reinforcer) contingent on toy play. In order to maintain high levels of object manipulation for extended periods of time (e.g., 30 min), it would have been necessary to delivery reinforcement on an intermittent schedule (e.g., fixed interval [FI], variable interval). However, several studies reported that the use of intermittent reinforcement schedules to maintain appropriate behavior may actually "induce" stereotyped behavior in individuals with disabilities (Emerson & Howard, 1992; Emerson, Thompson, Robertson, & Henderson, 1996; Lerman, Iwata, Zarcone, & Ringdahl, 1994; Wiesler, Hanson, Chamerlain, & Thompson, 1998). Nevertheless, as indicated by Lerman et al. (1994), most of these studies did not employ sound experimental designs and, therefore, the possibility of stereotypy induction has yet to receive adequate attention from researchers. Specifically, no study has produced "adjunctive" or "schedule induced" stereotypy in humans using a design that involved within-subject replication of a given intermittent schedule (e.g., FI 2 min). Given the frequently prescribed use of edible reinforcement in many behavioral

interventions, future research should evaluate the possible induction of stereotyped behavior during interventions that involve provisions of intermittent delivery of edible reinforcement.

The present series of experiments focused primarily on behavior that was presumably maintained by sources of automatic reinforcement, however; at least one repetitive response form that was targeted in these experiments was maintained by both social and nonsocial sources reinforcement (hand biting by Mike). Although the infrequent occurrence of hand biting made it unlikely that it would have been categorized as "stereotypy," some researchers suggest that many stereotyped response forms are sensitive to social reinforcement. In the most comprehensive study of social influences on stereotyped behavior, Kennedy, Meyer, Knowles, and Shukla (2000) reported that the stereotypic behavior of two individuals was maintained by multiple sources of reinforcement. In particular, Kennedy et al. concluded that one individual exhibited a stereotyped response form that was maintained by attention, escape from a task, and automatic reinforcement, depending on the stimulus context. Nevertheless, based on their data, the conclusions offered by the authors are subject to alternative explanations and are undermined by methodological shortcomings (e.g., data were not collected on mands that may have been exhibited in non-targeted contexts). In short, the most parsimonious explanation for the response patterns reported by Kennedy et al. is that the stereotypy was automatically reinforced and that alternative sources of stimulation, when obtainable through manding, competed with the stimulation produced by stereotyped behavior (e.g., Hanley, Piazza, & Fisher, 1997; Piazza, Fisher, Hanley, Hilker, & Derby, 1996). Nevertheless, based on the results from Kennedy et al. (2000) and other studies (Durand

& Carr, 1987; Mace, Browder, & Lin, 1987), Kennedy (2002) recently indicated that "…stereotyped responses are highly susceptible to socially mediated reinforcers" (p. 137). However, this conclusion is not necessarily supported by findings from these studies. Thus, in light of what appears to be a premature conclusion regarding the sensitivity of stereotyped behavior to social reinforcement, additional research using functional analysis methodology (e.g., Iwata et al., 1982/1994) is needed to fully explore the potential functions (operant and respondent) of stereotyped behavior.

Last, future research should examine the possible synergistic effects of behavioral and pharmacological interventions. In terms of altering preference for stereotypy, little is known about the combined effects of medication and behavioral intervention (e.g., environmental enrichment). For example, Sandman, Barron, and Colman (1990) showed that 50 mg of naltrexone reduced several individuals' SIB, but simultaneously increased levels of stereotypy--providing some evidence for response reallocation during conditions of pharmacological intervention. As a preliminary investigation of this possible phenomenon, the potential effects of various drug parameters (e.g., 25 mg, 50 mg, and 100 mg of naltrexone) could be evaluated during enriched vs. deprived environments to determine whether drug dosages enhance the probability that individuals' will reallocate responding to appropriate activities. Among many possibilities, pharmacological agents may decrease the value of stereotyped behavior (via altering biochemical levels; i.e., function as an abolishing operation), establish alternative stimulation as reinforcement (e.g., attention from a caregiver), or enhance stimulus control of alternative objects. Studies that evaluated the combined effects of methylphenidate and behavioral interventions (i.e., "therapeutic windows") on the academic behavior of children with

attention deficit disorder could potentially serve as a conceptual and methodological model to guide this line of research (e.g., Northup, Fusilier, Swanson, Roane, & Borrero, 1997; Rapport, Murphy, & Bailey, 1982).

In summary, the current study demonstrated the orderliness of response allocation to stereotyped behavior across a variety of environment conditions. To varying degrees, each participant showed differential sensitivity to manipulations that were intended to decrease the value of stereotyped responding, increase the value of engagement in an alternative operant, or a combination of both. As a whole, these experiments provide an approach for evaluating changes in a multiple-response repertoire, which may be imposed by behavioral intervention.

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BIOGRAPHICAL SKETCH

My graduate studies at the University of Florida (UF) began in the fall of 1999 under the supervision of Dr. Timothy Vollmer. During my graduate work at UF, I have expended considerable effort developing skills in the areas of undergraduate instruction, clinical and basic research, and clinical consultation. Under the guidance of Dr. Vollmer, I have become firmly committed to the development and training of students in the field of behavior analysis. I served as a teaching assistant for two years with Dr. Vollmer and, thereafter, as a graduate instructor for three consecutive semesters. In addition to the typical duties of being a graduate instructor, I recruited and subsequently trained a number of students from my classes to work in Dr. Vollmer's lab; many of these individuals still work in our lab and are pursing graduate studies in behavior analysis.

As a research assistant and a project coordinator in Dr. Vollmer's lab, I conducted research on a range of topics in behavior analysis including the assessment and training of communication abilities (verbal and picture-exchange communication), assessment of clients' preferences for behavioral interventions versus non-treatment conditions, analysis and treatment of self-injurious and aggressive behavior, assessment and treatment of phobic behavior, and the assessment of the relationship(s) between multiple repetitive behaviors (i.e., stereotypy). Although I have maintained an enthusiastic interest in the analysis and treatment of aberrant behavior exhibited by individuals with DD, the initiation of my graduate work with Dr. Vollmer marks an obvious shift in the nature of my research from primarily clinically based intervention to a broader scoped conceptual

analysis of aberrant behavior. Nonetheless, the overall focus of my research continued to be analyses of automatically reinforced behavior.

My area paper is a review of literature as it pertains to the classification, assessment, and treatment of non-injurious repetitive behavior (i.e., stereotypy). My review of this literature revealed a number of inconsistencies in mainstream classification of stereotyped behavior. Many studies arbitrarily classify behavior as stereotyped based on repetition and invariance of a single topography, without reference to the proportion of time allocated to the behavior. Other researchers categorize behavior as stereotypy merely based on movement invariance, which may be too broad as repetitious movement is obviated, or include repetitive behaviors maintained by social reinforcement. My area paper attempts to delimit the categorization of stereotypy to behavior that involves movement repetition and behavior maintenance in the absence of social reinforcement.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy R. Vollmer, Chairman
Associate Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Brian A. Iwata
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy D. Hackenberg
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Mark R. Lewis
Professor of Psychiatry

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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